geol survey

GUIDE LEAFLET 1974-A and D

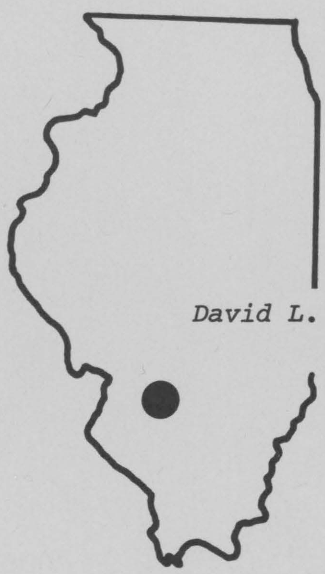
GUIDE LEAFLET

GEOLOGICAL SCIENCE FIELD TRIP

BREESE AREA

Clinton County

Breese and Carlyle 15-Minute Quadrangles



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Host—Mater Dei Catholic High School

May 11, 1974

October 26, 1974

Sponsored by the

ILLINOIS STATE GEOLOGICAL SURVEY

Urbana 61801

TO THE PARTICIPANTS:

The Geological Science Field Trip program is designed to acquaint Illinois residents with the landscape, the rock and mineral resources, and the geological processes that have led to their origin. With this program, we hope to stimulate a general interest in the geology of Illinois and a greater appreciation of the state's vast mineral resources and their importance to the over-all economy.

We encourage you to ask the tour leaders any questions that may occur to you during the trip. Discussion often clarifies points that otherwise would remain confused to many of the participants. We also invite your written comments upon the conduct of the trips so that we might improve them as much as possible.

Additional copies of this guide leaflet, as well as itineraries for field trips that have been held in the past, may be obtained free of charge by writing to the Illinois State Geological Survey. The itinerary maps for each field trip can be purchased for 10 cents each.

Several of the stops along this itinerary are located on private property whose owners have graciously given us permission to visit their lands. Please obey the instructions of your trip leaders and conduct yourselves in a manner that will show respect for the property owners' cooperation. Please do not litter, or climb on fences, and leave all gates as found, so that we may be welcome to return on future field trips. These simple rules of courtesy also apply to public property as well. For the convenience of those persons who may use this itinerary at some future time, the names and addresses of every private property owner are listed for the respective stops on a page at the back of this guide leaflet. Whenever possible, always attempt to obtain permission when visiting private property.

We hope that you enjoy today's field trip and will attend others in the future.

THE STAFF
EDUCATIONAL EXTENSION SECTION
ILLINOIS STATE GEOLOGICAL SURVEY

BREESE GEOLOGICAL SCIENCE FIELD TRIP

INTRODUCTION

Loose sediments--layers of clay, silt, sand, gravel, and their mixtures--cover the layers of solid rock in the Breese field trip area and form the land surface. The loose sediments were moved onto the land by winds, streams, and glaciers in the past million or more years during the interval of geologic time named the Pleistocene Epoch. These deposits are shown on figure 1 as the layer labeled "Quaternary."

The rock layers exposed at a few places in stream banks and quarries are thin beds of sandstone, shale, limestone, and coal. They are sedimentary rocks and were once layers of sand, clay, shell debris, and peat. These sediments accumulated during the latter part of the Pennsylvanian Period in a shallow sea and in the deltas and swampy lowlands bordering the sea. The Pennsylvanian Period began about 310 million years ago and lasted about 40 million years. Figure 1 shows the Pennsylvanian beds and the layers of older sedimentary rocks below them.

The surface of the Breese area is basically a plain, which is slightly roughened by a few low hills, ridges, and the wide shallow valleys of Shoal Creek and the Kaskaskia River. The plain is a till plain--a slightly uneven blanket of loose sediment, or till, deposited by a glacier. The low, rounded hills and the ridges are also glacial deposits. Some of them contain sand and gravel that glacier meltwaters falling off the ice heaped up. Water draining across the field trip area since the last glacier melted off it has cut and largely refilled the present valleys of the Kaskaskia River and Shoal Creek and eroded the modern drainageways. At present, the larger drainageways are wide, shallow valleys with swampy bottoms that contain meandering (winding and turning) streams.

The mineral and rock commodities now produced in Clinton County are common sand and gravel from glacial deposits; crude oil from porous Mississippian, Devonian, and Silurian rocks; and broken and crushed limestone from the Shoal Creek Limestone Member of Pennsylvanian age. Until 1960, coal was mined underground at Breese, Beckemeyer, and other places in the county. During the period of settlement, individual operators burned lime and brick, quarried building stone, and dug coal from thin bank exposures. Water sufficient for farm and domestic needs is obtained from shallow wells in thin beds of glacial sand and gravel and from thin Pennsylvanian rock beds that are fractured or porous. Breese takes its water supply from Shoal Creek, Carlyle from the Kaskaskia River.

GEOLOGY OF THE BREESE AREA

The Precambrian and Paleozoic Deposits

The beds of sedimentary rock under the loose Quaternary sediments in the Breese area probably have a total thickness varying from 6500 to 7500 feet. These sediments accumulated during the Paleozoic Era and represent the interval of geologic time beginning with the Cambrian Period about 550 million years ago and ending with the Pennsylvanian Period about 270 million years ago. The Paleozoic rocks rest on Precambrian granites or similar igneous rocks, which are about 6700 feet below the surface at Breese.

The Illinois Basin - Figures 1 and 2 illustrate the relationship of the Paleozoic beds to the Precambrian igneous and metamorphic "basement" rocks in Illinois. The basement rocks form a spoon-shaped depression in the earth's crust,

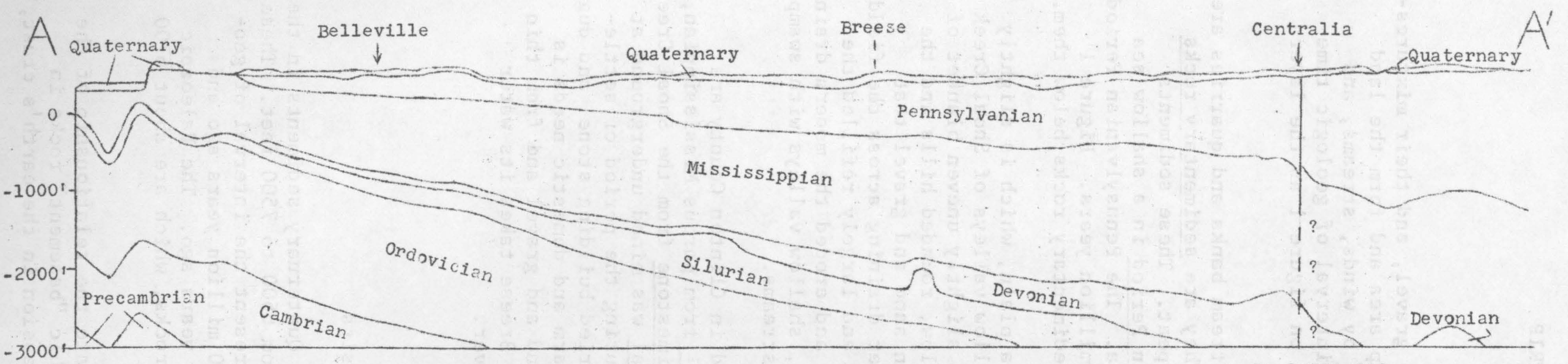


Fig. 1 - East-west geologic cross section A-A' along a line extending through Belleville and Centralia. (Adapted from Cross Section C-C' on <u>Geologic Map of Illinois</u>, Illinois State Geological Survey, 1967.)

Scale 1:500,000

1 inch equals approximately 8 miles

10 0 10

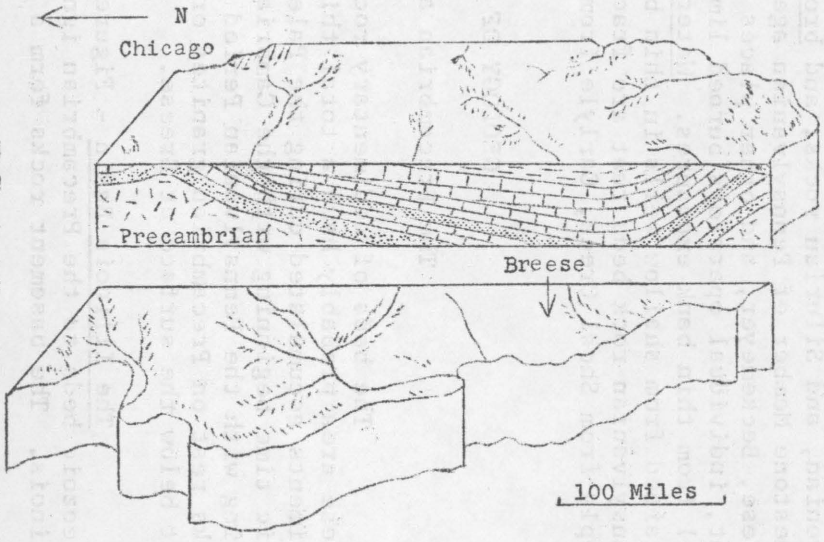
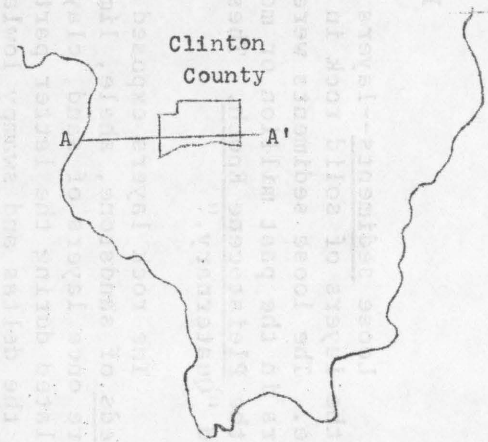


Fig. 2 - North-south cross section through Illinois showing the Paleozoic strata in the Illinois Basin.



Location of cross section A - A'.

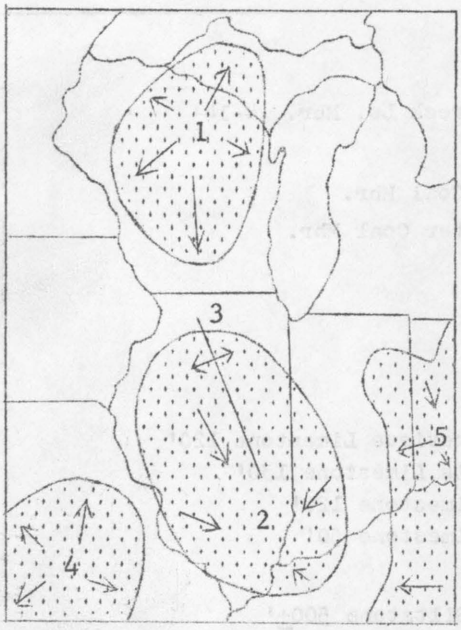


Fig. 3 - Locations of (1) the Wisconsin Arch, (2) the Illinois Basin, (3) the axis of the La Salle Anticlinal Belt, (4) the Ozark Dome, and (5) the Cincinnati Arch. (Arrows point down slope on the structure.)

and that depression is filled with sedimentary beds. This depression is called the Illinois Basin, and its deepest part, in southeastern Illinois, contains sedimentary beds about 13,500 feet thick. These deposits were much thicker, but erosion has planed off the top beds in the past 270 million years or so since late Paleozoic time.

Figure 3 shows the outlines of the Illinois Basin and the domes and ridges that have been formed by crustal warping since Precambrian time.

The Precambrian surface under the field trip area slopes down to the southeast toward the deepest part of the basin. The layers of sedimentary rocks also dip--slope down--about 30 feet per mile toward the east--or more exactly, to the east-southeast. The igneous and metamorphic rocks are exposed at the surface in the Baraboo Range of Wisconsin and the Ozarks of Missouri. In Illinois, the Precambrian rocks are largely granite and are known only from the samples of a few exceptionally deep test wells.

The History of the Paleozoic in Illinois - The Precambrian granite solidified from magma 1.2 to 1.5 billion years ago, deep under the earth's surface of that time. By the beginning of the Paleozoic Era, as much as a billion years later, erosion had cut away the covering rocks, and the granite was exposed and formed the land surface. But at the beginning of the Paleozoic Era the earth's crust under Illinois gradually sagged until shallow seas covered the whole region shown by figure 3. Throughout the Paleozoic--intermittently, slowly, and at different rates--the Illinois Basin settled, and thick layers of sediments accumulated in it. In general, mud and sand washed from the land into the nearshore parts of seas to make layers of shale and sandstone. Lime sediments derived largely from the shells and skeletons of sea animals accumulated offshore to make limestones. The Ozark Dome, the Wisconsin Arch, and the Cincinnati Arch (fig. 3) also were usually covered by seas. However, these structures sank more slowly than the basin and at times were even gently warped up. Paleozoic beds generally thin toward and over these structures, because many times little or no sediment was deposited on them, or if deposited was eroded off.

The Paleozoic System in the Breese Area - Figure 4 illustrates the layers of Paleozoic rocks underlying the field trip area. This geologic column, the route map, and the geologic map of Illinois in the appendix show that strata in the upper part of the Pennsylvanian System form the bedrock surface in Clinton County. In the field trip area, bedrock outcrops consist of the Shoal Creek Limestone Member and the shales and sandstones that occur a few feet above and below it. The entire Pennsylvanian and underlying Mississippian Systems have been frequently penetrated by oil test borings, many of which extend down into the older Devonian and Silurian Systems. The Cambrian and Ordovician Systems, which make up a little more than the bottom half of the Paleozoic column, are not well known in this part of the state--few wells penetrate them because they do not contain potable water and are not known to contain crude oil.

East of the Breese area, the Paleozoic rocks are broken by the near-vertical Centralia Fault, which extends north-south about 8 miles through Centralia. It is shown in figure 1.

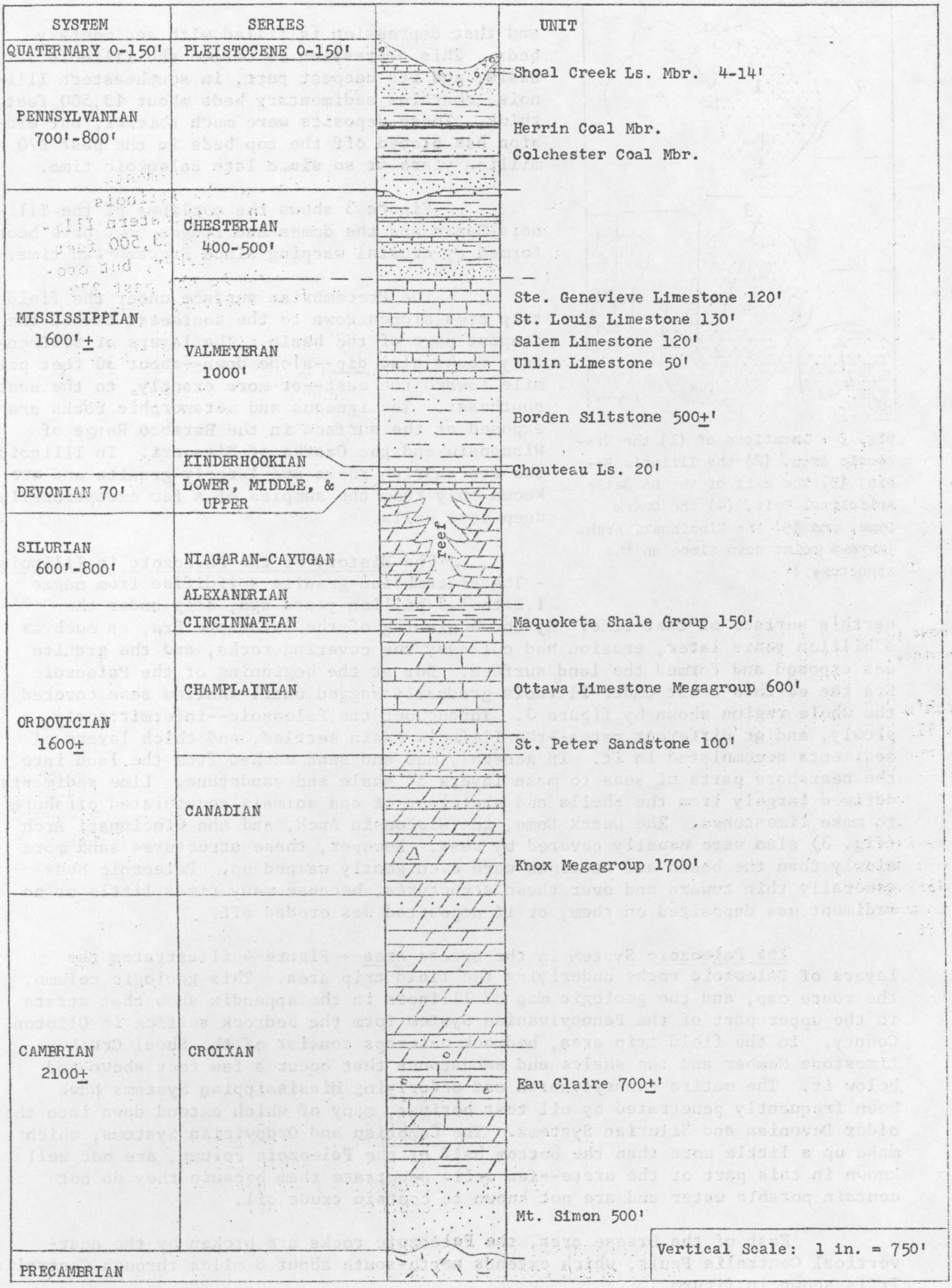


Fig. 4 - Graphic column showing rock units in the Breese-Carlyle area.

The Pennsylvanian System - The Pennsylvanian System in Illinois consists of more than 500 rock units of sandstone, shale, limestone, coal, and clay. Several hundred of these units have features that make it possible to recognize them from place to place in Illinois and adjacent states, and more than 130 of them have been given formal geologic names. About 90 percent of the thickness of the system consists of sandstone and shale units that are commonly a few tens of feet thick. The remainder of the system is composed of units of clay, black shale, coal, and limestone--these commonly ranging in thickness from a few inches to several feet.

The Pennsylvanian units typically occur in sets which have a sandstone at the bottom, a coal near the middle, and a black shale and limestone near the top, gray shales occurring between many of the beds. About 50 of these sets, which are called cyclothems, have been named in Illinois. A section in the appendix of this guide leaflet titled "Depositional History of the Pennsylvanian Rocks" discusses the origin of the units.

The Quaternary Deposits

In the past million years or so, glaciers, wind, and water have eroded the field trip area and deposited sediments on it. The deposits of glaciers and their meltwaters are collectively called drift. Wind deposits are called loess (say "luss" to rhyme with "fuss"). Running water lays down alluvium. The natural features of the present land surface are the effects of glaciation, wind, and running water.

The Pleistocene Deposits - (The appendix section titled "Pleistocene Glaciation in Illinois" provides the background for this discussion and illustrates it.) It is likely that at least three glaciers from continental ice sheets covered the Breese area. Apparently the first glacier entered the area during the Kansan (second) glaciation. It was a lobe that flowed southwestward from Canada through the basin of Lake Erie and into Illinois. No deposits from this glacier have been identified in the field trip area, but some have been found north and southwest of here and establish the former presence of the ice in this area.

Glaciers next entered the Breese area during the Illinoian (third) continental glaciation. During the Illinoian, glaciers twice advanced across this area. These advances, called the Liman and Monican, flowed southwestward from Canada through the basins of both Lake Michigan and Lake Erie and deposited several layers of till over most of the state. Beds of outwash sand and gravel carried from the ice front by meltwater occur under these tills in places.

The second Illinoian glacier, the Monican, was the last to cover this area. It deposited the upper layer of till, which is at or near the surface, and created the present upland topography. After covering the area, the glacier evidently stagnated--stopped moving and melted in place--for some of the low ridges and hills in the Breese area are heaps of bedded sand and gravel deposited in the ice field or at its edge by flowing meltwater. Such features are not formed, or are destroyed, if a glacier continues to flow as its front melts back, or retreats.

The fourth, or Wisconsinan, glaciation did not reach the field trip area. The meltwater from this ice sheet, however, did drain down the Kaskaskia Valley, eroding it at first when the ice was distant and the floods of water were relatively free of sediment. Later, as the ice front came closer to the area, sediment-laden meltwater reached the area and almost entirely filled the Kaskaskia Valley.

Some test holes drilled between Posey and Hoffman (south of Carlyle on Route 161) penetrate the alternating layers of till and outwash that fill the old Kaskaskia Valley, which is cut deeply into bedrock most of its length across Clinton County. The bedrock valley is roughly parallel to the present river, but its midline crosses Highway 50 about halfway between Carlyle and Huey. At this point the floor of the bedrock valley is about 150 feet below the land surface. In contrast, the bedrock surface under the level uplands is generally less than 50 feet below the surface of the drift.

Loess - In Illinois and much of the Midwest, the surface layer covering areas between drainageways is a very fine grained, loose sediment called "loess." Loess is a deposit of wind-blown dust. During the Wisconsinan glaciation, meltwater flowing down the Illinois and Mississippi Valleys carried immense quantities of fine sediment--silt and clay--downstream and deposited them on the wide valley floodplains. In the cooler seasons when the ice sheet melted less, the floodplains dried out and winds blew up clouds of dust that finally settled and gradually, over thousands of years, built up the loess deposits. Loess deposits thin downwind from their source valley. The loess at the west edge of Clinton County may be as much as 8 feet thick. At the east edge, farther downwind from the Mississippi Valley, it is usually little more than 4 feet thick.

Modern Sediments - Since the end of the Wisconsinan glaciation, the runoff from rain and melting snow has been moving sediments from higher places in the terrain into lower places, from knolls and hills into swales and floodplains. Water-laid sediment--alluvium--forms layers in the floodplains of streams and rivers. Human occupation of the area has generally accelerated erosion of the surface because settlement and farming have improved drainage and removed most of the native cover, leaving much of the land bare the year around, thereby hastening runoff and increasing its erosive powers. Carlyle Lake is a large sediment depository that is gradually being filled with the alluvium that its waves wash from its shores and its tributaries wash from their watersheds.

MINERAL PRODUCTION

Crude oil, stone, sand and gravel* - In 1972 Clinton County produced 678,000 barrels of crude oil, having an estimated value of $2,354,000. Since 1888 the county has produced a total of 81,905,000 barrels. No natural gas was produced in 1972, although there has been minor production in the past. In 1972 the county produced 153,000 tons of common sand and gravel, having an estimated value of $133,000. All the sand and gravel was shipped by truck. Because there was only one quarry operator in the county that year, no data on the quantity and value of crushed and broken limestone for agricultural and construction purposes have been released. Mineral industries in Clinton County employed 4,879 people in 1972. The total value of mineral materials mined (extracted in any way from the earth) in Illinois in 1972 was $701,242,000--a sum that does not include the value of mineral materials processed and manufactured in the state.

In the field trip area, crude oil is pumped from pay zones--oil-bearing rock layers and bodies--in Mississippian, Devonian, and Silurian beds. The

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* Data compiled by the Mineral Economics Group of the ISGS from information furnished by the U.S. Bureau of Mines and other sources. For all sources, see Ramesh Malhotra, 1974 (in preparation), "Illinois Mineral Industry in 1972 and Review of Preliminary Mineral Production Data for 1973," Illinois Geol. Survey Illinois Minerals Note 57.

Mississippian pay zones (from upper to lower) are in the Golconda Limestone Group, the Cypress Sandstone, the Yankeetown ("Benoist") Sandstone, and the St. Louis Limestone. The others are in the Devonian Geneva Dolomite Group and in marine reefs in the Silurian.

A few sand and gravel deposits large enough to be worked commercially are found in the hills on the upland and in the outwash that partly fills the Kaskaskia Valley. The hill deposits are ice-contact features: meltwater from the last glacier in the area washed sand or gravel into depressions on the ice or at the ice margin. The sand and gravel deposits in the valley are the better washed and better sorted parts of the sediment carried by glacial meltwater that drained down and partly filled the Kaskaskia Valley.

The Shoal Creek Limestone Member is the only local source of limestone in the county. Most of its outcrops are north of Breese, in the channel of Shoal Creek and the valleys of its western tributaries. In places the bed is as much as 12 to 14 feet thick.

Ground water - In Clinton County wells in bedrock aquifers generally supply only enough water for domestic and farm use. The aquifers are thin Pennsylvanian units--somewhat porous sandstones and fractured beds. However, several villages in the southwestern corner of the county do obtain adequate water supplies from a Pennsylvanian sandstone. The underlying Mississippian and older aquifers that supply potable water in other parts of the state contain brackish and saline waters in this region.

Wells in the thin drift on the uplands obtain water from thin, discontinuous sand and gravel beds and are sufficient for farm and domestic supplies. Municipal and industrial water supplies might be found in thick sand and gravel deposits that partly fill the Kaskaskia Valley. However, the largest communities in the field trip area use surface water. Breese pipes water from Shoal Creek, 2 miles east of town. Carlyle takes water from the Kaskaskia River below Carlyle Dam.

In the past - No coal has been mined in Clinton County since 1960. It is estimated that 38,656,325 tons of coal were produced in the 79 years for which records of the mining exist. All of the mines worked the Herrin (No. 6) Coal Member in the field trip area. At Breese the Herrin Coal was about 7 feet thick and 380 feet below the surface.

As the region was settled. mineral resources were used in many ways that are not familiar to us now. At a few places in the county, blacksmiths and others made some slight use of several thin coals that could be dug from the banks of streams. In 1868, Henry Engelmann, who surveyed the geo logy of Clinton County, reported:

> As far as the Shoal-creek limestone extends, in the north-west and central parts of the county, it furnishes a superior building stone, and, when burnt, a good, but not very white lime. At a few other points some sandstone is quarried, and on Crooked creek, the areno-calcareous layers. In the south-western and north-eastern parts of the county, rock are not easily accessible, but good brick can be manufactured any where (in A.H. Worthen et al., 1868, The Geological Survey of Illinois, Vol. III: Springfield, Ill., p. 189).

Engelmann felt that "the important geological question for Clinton County" was whether or not the "Belleville coal of the lower Coal Measures"--what we call the Herrin Coal--was to be found under Clinton County. Extensively mined in St. Clair County to the west, it had not been penetrated by any mine or boring that he could discover. By indirect evidence, he concluded that the important Herrin Coal was present in Clinton and Marion Counties, and he made very good estimates of its depth. It seems probable, however, that the confirmation of his speculations existed in the log of a well drilled 864 feet deep by the Illinois Central Railroad in Centralia in 1857. We know today that it was deep enough to reach the coal, but Engelmann could not gain access to the log, being told that "it was packed away with other old documents of the company." At any rate, not many more years passed before the Herrin Coal was mined in Clinton County.

ITINERARY

0.0 0.0 Assemble at Mater Dei Catholic High School. Head east on 9th Street.

0.0 0.0 <u>Stop 1</u>. Street geology of the school property. (SE¼ NW¼ SW¼ Sec. 15, T. 2 N., R. 4 W., Breese 15' Quadrangle.)

The environments constructed by human beings contain many things of interest to students of geology. A walk along any city street will reveal a variety of geological materials, features, and processes. The purpose of this stop is to demonstrate this idea by providing the scene for a self-conducted geological science field trip in the area in front of the school. The map (figure 5) shows the locations of points of interest by numbers. The numbers on the map refer to the numbers of the paragraphs below which explain the features viewed. Begin your field trip where you choose and follow your own interest.

A field trip like this can be taken by all students in school. Among other things, it illustrates that our society depends on the most ordinary kinds of earth materials; that earth materials are much involved in our artistic/esthetic activities; and that earth materials exposed at the earth's surface are continually being changed.

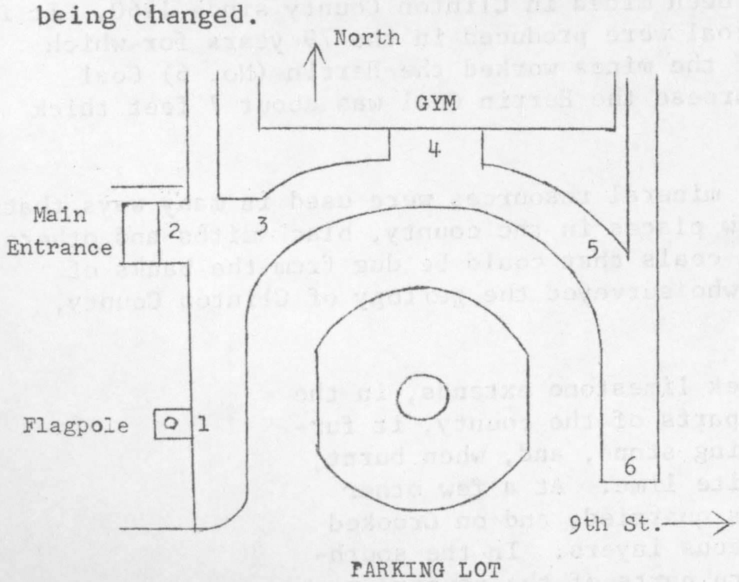


Fig. 5 - Street geology stops at Mater Dei Catholic High School, Breese.

<u>Point 1</u>. The base of the flagpole has broken away from the sidewalk and is tipped slightly. Concrete, like rock, is only slightly elastic at surface pressures and temperatures, and it breaks if too heavily stressed. Was the stress that caused this break the weight of the base and flag pole, or what?

<u>Point 2</u>. The brown stone in the steps and the low retaining walls at the main entrance is a rock called <u>dolomite</u>. The building blueprints identify it as "Winona Dolomite," the commercial name for the Oneota Dolomite of Ordovician age that is quarried at Winona, Minnesota. Saw marks in a few places indicate how the blocks were cut.

The peculiar branching, tubular structures in the rock may be fossils. They resemble both worm burrows and fucoids (flattened-tube forms thought to be the remains of marine algae). The layers of these structures and the long irregular pores between the layers give the rock its handsome appearance.

The walls of this entrance and of the gym's entrance are blocks of limestone. It is a type called calcarenite because it is composed of sand-sized particles (-arenite) of calcite (calc-). Close examination of the rock with both eye and 10-power handlens shows that the grains in this limestone are broken and whole fossils and pellets. This stone is Mississippian in age and is called the Salem Limestone (see figure 4) in Illinois. It is quarried at and in the vicinity of Bedford, Indiana, and one of its commercial names is the "Indiana Limestone."

Point 3. The pockmarked and scaling patches on the sidewalk are caused by salt fretting. Salt scattered on the walk to melt ice dissolved in the meltwater and soaked into the concrete with the water. As the sidewalk dried, salt crystals began to grow between the particles in the concrete, thrusting the particles apart and finally breaking loose chips from the surface.

Where the fine-grained surface of the concrete has scaled off, the coarse aggregate—broken gray limestone—is visible. Concrete is made by mixing certain proportions of sand, gravel or broken stone, cement, and water to make a fluid paste that is poured into a form to harden. Cement is a mixture of limestone and shale (or clay) that has been calcined--burned to a red heat—and then pulverized. Cement hardens after it is mixed with water because the compounds made by calcining take water into their structures and re-form, creating new minerals that bind each other (and whatever aggregates are present) into a rock-like mass. Areas of the sidewalk surface have a brown hue where glossy, sand-size grains of brown chert (jasper) are concentrated.

What traces of the activities of living things does concrete preserve? Why is there a thin, fine-grained surface zone on concrete walks?

Point 4. Panels of "Indiana Limestone" are used to face the walls of the gym entrance. With the exception of the stone facings, the walls of the school are made of brick. Bricks are molded blocks of clay that are dried and then fired (heated) in a kiln to temperatures high enough to fuse some of the very fine quartz grains and clay minerals that make up the clay. Firing causes the original minerals to combine to some extent and form new minerals.

The surfaces of a brick often preserve marks that indicate how it was formed and handled before firing. Color and color markings and some surface textures are the result of clay composition, kiln temperature and atmosphere, and firing procedures. Many bricks have applied decorative textures. Brick resembles some natural metamorphic rocks, such as the shales burned by burning coal beds or those baked by contact with molten lava or magma.

Point 5. Note the large cracks in the sidewalk. It is not clear what stresses are causing them. Similar vertical cracks called joints are exposed on the surface of rock beds at Stop 2, but it cannot be assumed that the same kinds of stresses caused both.

The driveway is made of asphalt, a mixture of sand and gravel (or broken stone) bound with tar. Note that broken limestone is used for surfacing the parking lot. The broken stone and gravel used for concrete and asphalt aggregates and for road "gravel" often come from nearby sources.

Point 6. The statue of Mary in the circle is carved from white marble. Marble is a metamorphic rock formed when limestone is subjected to subterranean heat and pressure sufficient to recrystallize it. Marbles are excellent material for sculpting. Polished marble has a beautiful, lustrous, soft-looking surface that can enhance representations of human subjects. Marbles may weather relatively fast if exposed to wet, severe climates like ours. What rock is the pedestal of the statue made of?

Look west across the driveway to the opposite side. The curb at the end of the sidewalk is sunken and broken. The earth under it has fallen away for some reason.

0.0 0.0 Leave Stop 1. Continue ahead (east) on 9th Street.

0.05 0.05 STOP. North Plum Street. Continue ahead (east).

0.3 0.35 STOP. North Walnut Street. TURN RIGHT (south).

0.35 0.7 STOP. Fourth Street (U.S. Route 50). TURN LEFT (east).

0.5 1.2 Leave Breese city limits. Continue ahead (east).

0.2 1.4 To the right (southeast) are several old buildings and tall smokestacks that mark the location of the abandoned mine shaft of the Breese Coal Company, Inc. The surface elevation of the shaft top is 435 feet above mean sea level; and the Herrin (No. 6) Coal Member is 392 feet deep, occurring at an elevation of 43 feet above mean sea level. This mine was developed as a "shipping coal mine," that is, the majority of its output was shipped by the railroad westward to markets in the St. Louis area. However, during the last year of its existence, 1957, it was operated as a "local mine," from which the coal was used exclusively for the local trade, and none was shipped by rail from this area. In that year, only 15,546 tons were mined before it was closed in May. According to the available records, this mine reached its peak during 1918, when 293,029 tons of coal were mined. These records also show that this mine had a total production of 6,329,114 tons of coal during its lifetime.

A brief description of the coal and some of its associated strata from the Survey's Mine Notes follows:

Limestone (Brereton Member), conglomeratic			1'2"
Shale, black, slaty			2" - 3'
Herrin (No. 6) Coal - Lenses and bands of pyrite occurred throughout the coal.			7'3"
Coal	62"		
Clay	7")	Blue Band	
Coal	2")	Blue Band	
Clay	2")	Blue Band	
Coal	14"		
Underclay			2'6"

0.2	1.6	CAUTION. Prepare to turn left.
0.1	1.7	CAUTION. Crossroad. TURN LEFT (north).
0.8	2.5	To the upper right (northeast) is a large red-brick house with several barns to its left. These buildings are located just south of the site of the old mill at Becker Falls. Just west of the mill site, a shaft was sunk many years ago in hopes of reaching coal with which to power the mill during times of lower water levels along Shoal Creek. The shaft sinking was attempted two different times but was finally abandoned because of lack of funds. Later when the mine shaft was successfully completed a little over 1½ miles to the south at the Breese Coal Company, Inc. location, it was learned that the shaft near the Falls had stopped between 12 and 16 feet above the productive Herrin (No. 6) Coal.
0.2	2.7	CAUTION. Crossroad. TURN LEFT (west).
0.85	3.55	St. Joseph's Hospital to the right.
0.15	3.7	STOP. North Walnut Street limits. TURN RIGHT (north).
0.5	4.2	Note the even upland across this area.
0.65	4.85	CAUTION. T-road from left. TURN LEFT (west).
0.05	4.9	CAUTION. T-road from right. TURN RIGHT (north).
0.3	5.2	View to upper left (northwest) of a low knoll that resulted from the Illinoian glaciers that covered this area.
0.25	5.45	CAUTION. T-road. TURN LEFT (west).
0.35	5.8	Note view ahead and to the left from the crest of the road across this low knoll.
0.15	5.95	STOP. Crossroad. 2-way stop. TURN RIGHT (north).
1.3	7.25	To the right (east-northeast) is the operating pit of the Buehne Quarry Company.
0.25	7.5	To the left, just south of the village of St. Rose, is another low, small knoll of glacial origin.
0.4	7.9	STOP. T-road from right. TURN RIGHT (east).
0.55	8.45	CAUTION. TRUCK CROSSING. The Buehne operating quarry pit is located ½ mile to the south.
0.25	8.7	Buehne Quarry Company office is to the left.
0.2	8.9	STOP. T-road. TURN RIGHT (south).
0.95	9.85	<u>Stop 2</u>. Pennsylvanian Shoal Creek Limestone Member and Pleistocene Glasford Formation. (PARK as far off of the road as is safely possible.) (NW¼ SW¼ NW¼ and SW¼ NW¼ NW¼ Sec. 35, T. 3 N., R. 4 W., Breese 15' Quadrangle.)

The geologic sections to be seen here are exposed on the east side of the road, on both sides of the farm road that goes back to the east at the stop. The Pennsylvanian section is south of the farm road, cropping out in the stream bed and bank between the road and fence. The Pleistocene section is in the road cut about 90 yards north of the farm road, vertically down the middle of the knoll and southward in the ditch bottom.

The Pleistocene Section - The top 5½ feet of the section is loess which accumulated during the Wisconsinan glaciation in the period between about 75,000 years ago and 7,000 years ago. During this time, winds blew dust off the floodplains of the glacial rivers carrying outwash down the Mississippi and Illinois Valleys and deposited it across the state as loess.

The loess blanket covered the Illinoian drift (the lower 10½ feet of the section) which was deposited during the third glaciation, more than 175,000 years ago. For 100,000 years or more--between the time it was deposited by the glacier until it was buried by the loess--the surface of the drift was exposed to weathering. As a consequence, a deep soil, called the Sangamon Soil, developed in it. The long interval of weathering produced the strong colors in the upper 3½-foot Illinoian unit and leached the calcite and dolomite out of it and the unit under it. These units are till, the sediment borne and deposited by glaciers.

The point to understand is that there is a modern soil developing from the top of the loess (the present land surface) and an ancient soil that developed on the till surface before it was covered by loess.

WISCONSINAN STAGE

Loess - Yellowish brown with 1' of very dark grayish brown top soil. Few or no pebbles, slightly sandy at base. No calcite or dolomite reaction with acid. 1% sand, 64% silt, 35% clay in sample from the middle of unit.....5½'±

ILLINOIAN STAGE

Glasford Formation

Till - Strong brown to yellowish brown, mottled and veined gray. 16% to 24% sand, pebbly. No calcite or dolomite reaction with acid. 18% sand, 47% silt, 35% clay in sample from the middle of unit.........3½'±

Till - Yellowish brown veined grayish brown with black manganese skins. 39% to 42% sand, top 2' very pebbly. A very faint acid reaction. 40% sand, 32% silt, 28% clay in sample from the middle of the unit...7'±

16'±

(PENNSYLVANIAN SYSTEM: The till rests on the calcareous, rust brown sandstone described below.)

The Pennsylvanian System - This outcrop displays the upper part of the Shoal Creek Cyclothem and what is apparently the basal unit of another cyclothem, the gray sandstone bed. Note that the dashed line on the route map that marks the contact of the Bond and Modesto Formations is along the base of the Shoal Creek Limestone. Figure 4 illustrates the positions of these units. The Pennsylvanian System is also discussed in the Introduction and the Appendix.

At this stop, one sees an unconformity--a gap in the geologic record where a rock unit is not overlain by its immediate successor in time but by one far removed from it in time. The unconformity here is the plane of contact between the Pleistocene and Pennsylvanian sediments.

The Pennsylvanian rocks which are more than 270 million years old are overlain by Pleistocene sediments thought to be no more than 300 thousand years old. What record remains here of the intervening 269,700,000 (more or less) years? No sediment record. This region was being eroded during that time. Near the end of the Pennsylvanian Period, Illinois and the rest of the Illinois Basin rose above sea level and--except for the region of the Mississippi Valley south of Johnson and Union Counties in Illinois--was not submerged again. A region above sea level must be eroded if it remains above sea level long enough.

This section and the Pleistocene section illustrate how water dissolves carbonate rocks (limestone and dolomite). Water percolating into the ground contains dissolved carbon dioxide from the atmosphere and plant respiration, and this mildly acid solution corrodes limestone and dolomite. Examine pieces of the limestone and study the outcrop. Note how fossils on the corroded surfaces stand in relief and, in contrast, scarcely show in fresh fractures. Note how joints are widened and become wide soil-filled crevices and how the once angular blocks of stone are rounded off on corners and edges.

PENNSYLVANIAN SYSTEM
McLeansboro Group
Bond Formation

Sandstone - Light gray, calcareous (reacts with acid). Several ledges show in the hillside, but the unit is mainly seen as a zone of rust brown chips across the outcrop..2'±

Covered interval - Many limestone blocks show in the slope, but there are no ledges in place...............4'±

Shoal Creek Limestone Member - Grayish orange (weathered surface) and yellowish brown (fresh fracture). Outcrop is very weathered: it is split into beds no more than 4" thick. Very fossiliferous. Very fine grained. (Estimated total thickness is about 8' along this creek)..4'±

Modesto Formation

Shale - Olive gray, mottled rusty tan. Soft, thinly laminated but not coherent, crumbly. Calcareous.........1'±

Shale - Gray, thinly laminated, soft, becomes increasingly more fissile toward base..............................1'±

Shale - Black, hard, fissile......................................½'

12½'±

Base of section is in the creek bottom, at the fence.

0.0 9.85 Leave Stop 2. CONTINUE AHEAD (south).

1.4 11.25 CAUTION. T-road intersection. TURN LEFT (east).

0.25 11.5 Note slump in roadcut on left. The cut is too steep and when rainfall is plentiful, the Pleistocene materials become saturated, lose their rigidity, and flow outward, sometimes blocking ditches and roads.

0.05 11.55 Shale and thin-bedded siltstone occur in the lower portion of the roadcut. These beds occur just above the Shoal Creek Limestone, which is not exposed here.

0.25 11.8 CAUTION. Narrow bridge over Shoal Creek.

0.15 11.95 The itinerary here is along a portion of the old St. Louis-Vincennes Road established during the colonial days of Illinois.

0.15 12.1 A series of low knolls of glacial origin occur to the right (southeast)

1.05 13.15 Here the itinerary is along the old Goshen Road, which extended from the Ohio River at Shawneetown northwestward to the American Bottoms, south of Edwardsville in Madison County. The American Bottoms was uninhabited at the time but supported a lush plant growth which inspired a Baptist missionary exploring the area to call it the Land of Goshen.

The tank batteries and well sites to the left are in the Frogtown North oil field, which was discovered in 1951 and has a total proved area of 420 acres. By the end of 1972, 5 wells had been completed into the Mississippian (Valmeyeran) St. Louis Limestone, which occurs at a depth of 1,200 feet. This pay zone averages 10 feet in thickness and extends over a proved area of 60 acres in a dome structure. An additional 29 wells had been completed by the end of 1972 into Devonian-Silurian limestone reef rocks at a depth of 2,250 feet. This latter pay zone averages 8 feet in thickness and extends over a proved area of 350 acres. The deepest test in this field was stopped in the Silurian at a depth of 2,456 feet. Nineteen wells were producing in this field at the end of 1972. Oil production for 1972 amounted to 15,800 barrels. Total production from this field through 1972 amounted to 2,052,000 barrels of oil. (Information about oil production at this point and others along the itinerary is taken from Jacob Van Den Berg and T. F. Lawry, 1973, ISGS Illinois Petroleum 100.) The illustration "Silurian Reefs, Southwestern Illinois" shows the location of the Frogtown North pool and the other Silurian reef pools in this region.

0.3 13.45 CAUTION. Frogtown crossroad. Continue ahead (southwest) through Frogtown.

1.2 14.65 STOP. Crossroad. Continue ahead (southeast).

0.3 14.95 Note the view to the south and southeast from this low knoll.

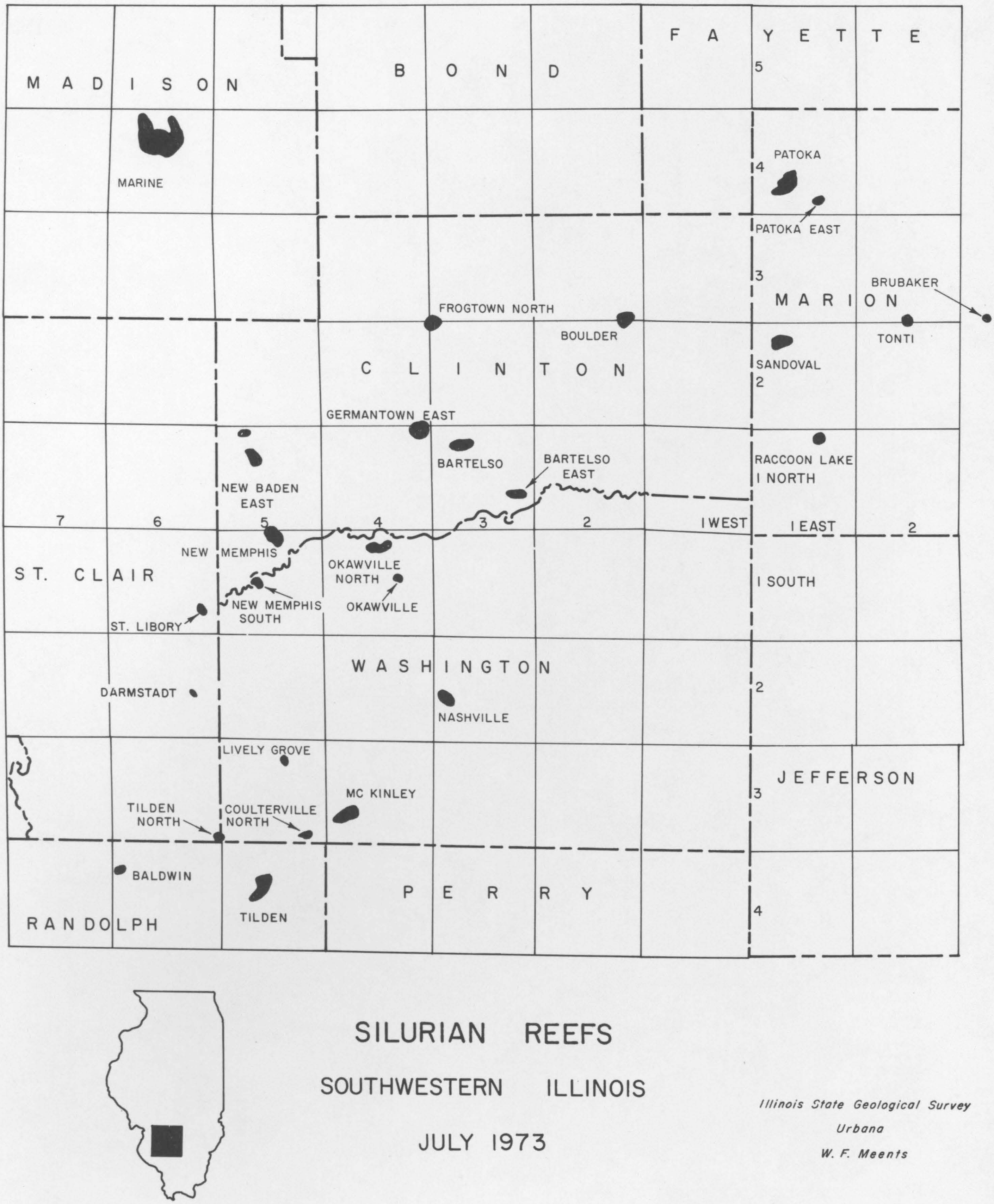
0.75 15.7 CAUTION. Narrow bridge over Beaver Creek.

0.5 16.2 CAUTION. Prepare to turn left.

0.15 16.35 CAUTION. Crossroad. TURN LEFT (north).

0.9 17.25 CAUTION. T-road. TURN RIGHT (east).

0.7 17.95 The tank battery to the upper left (northeast) is in the Carlyle oil field, which was discovered in 1911 and has a total proved area



SILURIAN REEFS

SOUTHWESTERN ILLINOIS

JULY 1973

Illinois State Geological Survey

Urbana

W. F. Meents

of 1,230 acres. Six wells had been completed by the end of 1972 into the Mississippian Golconda Limestone Group at a depth of 900 feet. This pay zone averages 10 feet in thickness and extends over a proved area of 10 acres along an anticlinal structure. A deeper pay zone in this field is in the Mississippian Cypress Sandstone (Carlyle sand), which occurs at a depth of 1,035 feet. Both producing zones are Chesterian units. By the end of 1972, 185 wells had been completed into this zone, which averages 20 feet in thickness. This pay zone has a proved area of 1,230 acres and occurs as a sand lens along an anticline. The deepest test hole in this field stopped in the Ordovician St. Peter Sandstone at a depth of 4,120 feet. Twnnty-one oil wells were producing in the field at the end of 1972. Oil production for 1972 amounted to 16,700 barrels. Cumulative production through 1972 has amounted to 4,092,000 barrels. A secondary recovery program of waterflooding was attempted in this field a number of years ago. It was discontinued because it did not appear to increase or sustain oil production from the field.

0.15 18.1 Pumping oil wells along both sides of the road.

0.15 18.25 CAUTION. Crossroad. Continue ahead (east).

0.75 19.0 CAUTION. Crossroad. TURN LEFT (north).

0.2 19.2 Tank battery to left.

0.8 20.0 CAUTION. Jog in road.

0.5 20.5 STOP. Crossroad. Continue ahead (north).

0.9 21.4 CAUTION. Narrow culvert.

0.6 22.0 CAUTION. Crossroad. Continue ahead (north).

0.25 22.25 The well heads located in this area are in the Carlyle North oil field, which was discovered in 1950 and consists of a proved area of 530 acres. As of the end of 1972, 45 wells had been completed into the Mississippian Yankeetown Formation (Benoist sand)--a Chesterian unit--at a depth of 1,150 feet. The deepest test hole drilled in this field was stopped in the Devonian at a depth of 2,558 feet. In 1972 the 33 wells that were active in the field recovered 17,600 barrels of oil from a sand lens that occurs along an anticlinal structure. Total oil production from this field has amounted to 839,400 barrels up to the end of 1972.

0.1 22.35 CAUTION. Narrow bridge.

0.25 22.6 Tank battery on right.

1.4 24.0 STOP. T-road. TURN RIGHT (east).

0.3 24.3 The low knolls to the left (north and northeast) in the distance are part of a series of similar small hills that extend northeastward out of the area.

0.2 24.5 <u>Stop 3</u>. Tank battery and wells of the Beaver Creek South oil field. (NW cor. Sec. 13, T. 3 N., R. 3 W., Breese 15' Quadrangle.)

The Beaver Creek South oil field was discovered in 1946 and had a total proved area of 570 acres. The field is composed of a series of small pools

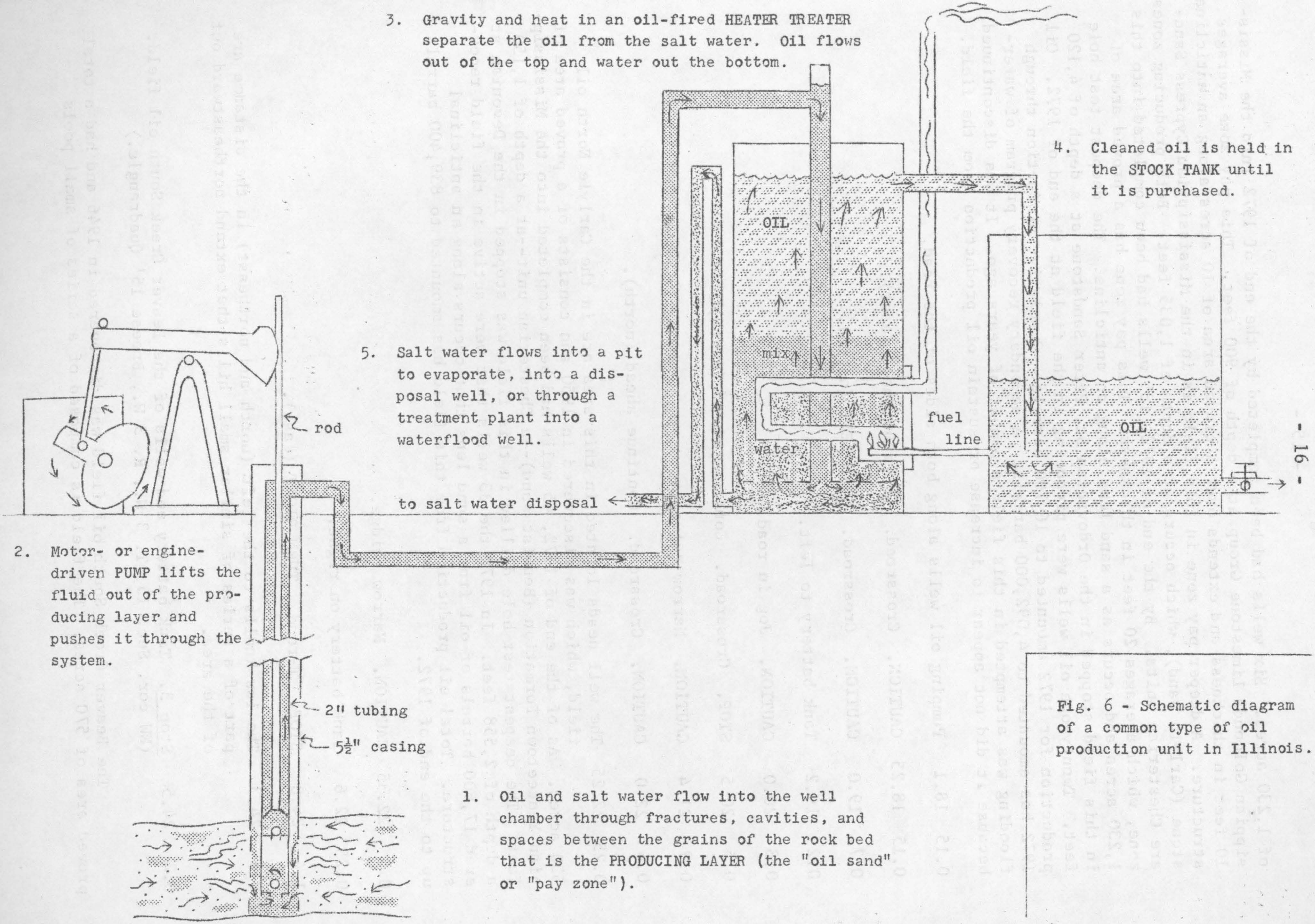


Fig. 6 - Schematic diagram of a common type of oil production unit in Illinois.

trending southwest-northeast for several miles. By the end of 1972, one well had been completed in the Mississippian Cypress sand at a depth of 1,005 feet. This pay zone has a proved area of 10 acres, averages 20 feet in thickness, and occurs along an anticline in the northeastern part of the field. This stop is in the southwestern part of the field in the area of the Mississippian Yankeetown Formation (Benoist sand). Oil production is from 560 proved acres (see fig. 4). By the end of 1972, 50 wells had been drilled into this pay zone, which averages 5 feet in thickness and occurs at a depth of 1,140 feet along an anticlinel structure. The deepest test hole in this field stopped in the Silurian at a depth of 2,606 feet. Oil production from this field during 1972 came to 12,700 barrels from 26 producing wells. Cumulative oil production through 1972 amounted to 664,400 barrels.

Figure 6 diagrammatically represents the equipment used to recover oil and hold it prior to sale. Crude is transported to the refinery from the production unit by pipeline or tank truck in this area.

0.0 24.5 Leave Stop 3. Continue ahead (east).

0.3 24.8 Cross Flat Branch of Beaver Creek.

0.7 25.5 STOP. Illinois Route 127. TURN LEFT (north) on Route 127.

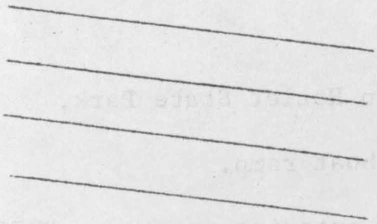
1.4 26.9 The itinerary here is ascending northeastward trending ridges of drift.

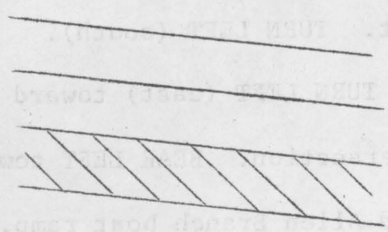
0.4 27.3 CAUTION. Prepare to turn right.

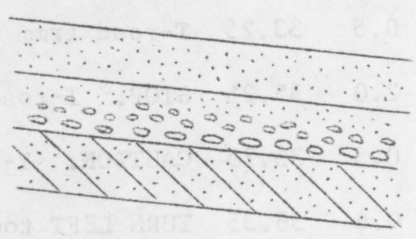
0.2 27.5 CAUTION. TURN RIGHT (east) on the Keyesport Road.

0.25 27.75 Stop 4. Pleistocene gravel deposit in glacially derived knoll. (NW cor. [regular] Sec. 6, T. 3 N., R. 2 W., Carlyle 15' Quadrangle.)

The gravel pit is excavated in a hill formed by the last glacier to cover this region during the second Illinoian advance. This hill, like others in the corner of the field trip area, is largely a deposit of meltwater-laid sand and gravel--outwash--that lies on top of the till deposited by the glacier. The evidence for this assertion comes from the disposition of the sediments in the beds and from structures in the beds such as cross-bedding and sorting. These features can be observed in the sediments deposited by present-day streams.

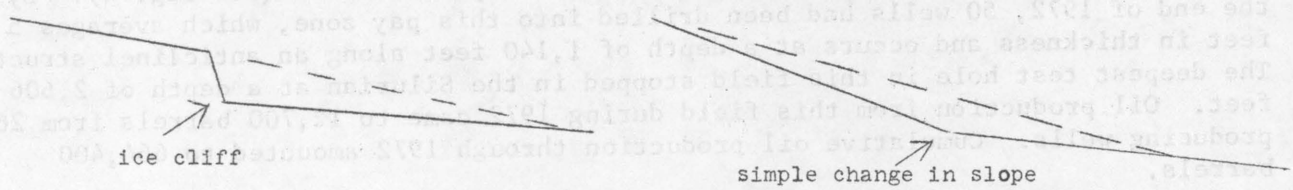

Bedding

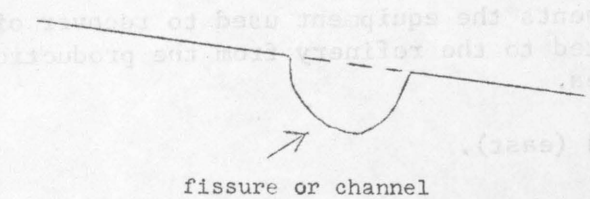

Cross-bedding


Sorted beds

This deposit was made as the glacier stagnated. Meltwater from the ice drained off the glacier in streams that ran on the surface of the glacier, and in fissures and tunnels through it and under it. These meltwater streams carried the earth materials that the moving glacier had picked up by shearing. Wherever flow in these water courses slowed, sediment too heavy for the slower flowing water to carry was dropped.

Generally speaking, a stream's flow, at a given time, slows wherever the gradient--or slope--of its bed decreases. The sketches illustrate three points on the surface of a glacier where streams flowing down them would slow and deposit sediments. Sediments would be deposited until the low spot in the slope would be filled in and a smoother grade (the dashed line) would be established.





This sand and gravel deposit is about 60 feet thick. To visualize how it was deposited, one must imagine places in the ice field and at its edge where the gradients of streams would change and permit the accumulation of 60 feet of sediment. Since this deposit is relatively narrow and high, such places might have been falls over ice cliffs, or fissures and meltwater channels in the ice. Because the sediments are thought to be deposited in contact with the glacier they are called <u>ice-contact deposits</u>. The Wisconsinan loess covers this ice-contact deposit. A number of solid ledges in the pit are beds cemented by calcite that was deposited from ground water that flowed through them.

0.0	27.75	Leave Stop 4 and continue ahead (east).
1.9	29.65	CAUTION. Prepare to turn right.
0.15	29.8	T-road from right. TURN RIGHT (south).
0.95	30.75	STOP. 2-way stop. Continue ahead (south).
1.0	31.75	STOP. Crossroad. 2-way stop. Continue ahead (south)
1.0	32.75	T-road intersection. TURN RIGHT (west) at Hopewell United Methodist Church.
0.5	33.25	T-road frmm left. TURN LEFT (south).
2.0	35.25	STOP. T-road. TURN LEFT (east) toward Eldon Hazlet State Park.
0.5	35.75	CAUTION. Y-intersection. BEAR LEFT toward boat ramp.
0.6	36.35	TURN LEFT toward Allen Branch boat ramp. On entering ramp area KEEP TO RIGHT.
0.35	36.7	<u>Stop 5</u>. Lunch and discussion of the Lake Carlyle Project. (NW¼ SE¼ Sec. 28, T. 3 N., R. 2 W., Carlyle 15' Quadrangle.)

The following project data are from the U.S. Army Corps of Engineers:

LOCATION - The Carlyle Dam is located on the Kaskaskia River near Carlyle, Illinois, about 107 miles above its mouth. The lake is about 50 miles due east of

PURPOSE - Carlyle Lake is a unit of the general comprehensive plan for the development of the Kaskaskia River Basin for flood control, water supply, fish and wildlife conservation, recreation, navigation, and downstream water quality control.

CONSTRUCTION - Construction of the $41 million project was started in December 1958 and completed in June 1967. In addition to the main dam, construction highlights included relocation of the Burlington Northern Railroad, plugging of oil wells, building of recreation areas, clearing of reservoir land, and the relocation of utilities, highways, and cemeteries.

LAKE - Storage in acre-feet (1 acre-foot = 1 acre of water 1 foot deep, or 325.775 gallons)

Flood-control pool..............700,000
Normal pool.....................233,000

Water areas, acres

Flood-control pool, top..........57,500
Normal pool, top.................26,000

Elevation, feet above mean sea level (msl)

Flood-control pool, top...........462.5
Normal pool, top..................445

Length, miles (approx.)

Flood-control pool...................25
Normal pool..........................15

Maximum width, miles (approx.)

Flood-control pool...................5
Normal pool..........................3.5

Shoreline, miles (approx.)

Normal pool..........................83

DAM

Type: earthfill

Height above stream bed, feet........67
Crest elevation, feet above msl.....472

Length, overall, feet..............6,570
Control gates, 4, size in feet..38 x 39

Spillway: Type, gate-controlled

Length, feet........................179
Crest elevation, feet above msl....425

Outlet works: Conduit: Left side of main dam

Inside diameter, inches............30
tapering to (inches)...............24

For further information, write to CARLYLE LAKE MANAGEMENT OFFICE, P.O. Box 30, Carlyle, IL 62231; phone 618-594-2484.

Along the lake one can observe instances of shore erosion by waves. Some of the limestone riprap used to armor the shores is fossiliferous.

0.0	36.7	Leave Stop 5. Continue ahead (south).
0.2	36.9	T-road intersection. TURN RIGHT and return to park entrance.
1.35	38.25	T-road from right. Continue ahead (west).
0.95	39.2	T-road from right on curve to left. Continue ahead (south) toward the west access area and Corps of Engineers headquarters.
2.85	42.05	STOP. TURN LEFT (southeast) and continue toward the picnic area overlooking the Carlyle Dam.
0.35	42.4	Carlyle reservoir dam to the left. Descend hill with caution.
0.45	42.85	CAUTION. Cemetery entrance.
0.25	43.1	STOP. TURN RIGHT (west) on Clinton Street.
0.1	43.2	STOP. Sixth Street. Continue ahead (west).
0.05	43.25	STOP. Seventh Street. Continue ahead (west).
0.3	43.55	STOP. Eleventh Street. Continue ahead (west).
0.05	43.6	STOP. Twelfth Street. TURN LEFT (south) on Route 127.
0.25	43.85	STOP. Junction with U.S. Route 50. Continue ahead (south) on Illinois Route 127.
0.1	43.95	CAUTION. RAILROAD CROSSING. Continue ahead.
1.3	45.25	Prepare to turn right.
0.15	45.4	T-road from right (Bartelso Road). TURN RIGHT (west).
3.8	49.2	Crossroad. TURN LEFT (south).
0.4	49.6	T-road from left. TURN LEFT (east).
0.7	50.3	Stop 6. View from Pelican Pouch. (SE¼ SW¼ SE¼ Sec. 3, T. 1 N., R. 3 W., Carlyle 15' Quadrangle.)

Breese lies northwest of this stop. The water tower, church steeple, and the Breese Mining Company chimney are visible. Carlyle can be seen to the north-northeast.

The elevation at this stop is about 550 feet above mean sea level, approximately 80 feet higher than the plain that extends north from this ridge. Pelican Pouch is a type of glacial feature--a ridge composed of drift. It is not clear, however, just how it was formed--whether it is an outwash feature like the hill at Stop 4 or an end moraine.

The view to the north is across a <u>till plain</u>. Glacial drift deposited during the Pleistocene Epoch has filled in and smoothed over a rougher surface cut in bedrock. If the drift were miraculously removed, we would see ahead of us a broad divide between two wide, south-trending valleys. The upland surface of the divide would be a little more than 400 feet above sea level (about 50 feet below the present surface). One valley would be just east of Breese, the other just east of Caryle and this stop. The valleys are about 4 miles wide, their floors about 100 feet below the surface of the bedrock divide. Their sides are gently sloped. Now they are filled with about 150 feet of drift.

0.0 50.3 Leave Stop 6. Continue ahead (east) along the ridge.

0.4 50.7 T-road from right. TURN RIGHT (east).

0.55 51.25 NOTE indiscriminate dumping of rubbish along ravine to the left.

0.3 51.55 T-road from left. Continue ahead (east) and then bear right (south).

0.4 51.95 Wisconsinan loess exposure to left.

1.05 53.0 USE EXTREME CAUTION. UNGUARDED RAILROAD CROSSING. DO <u>NOT</u> STOP ON TRACKS.

0.05 53.05 STOP. Illinois Route 161. TURN LEFT (east).

0.4 53.45 Cross Kaskaskia River.

1.7 55.15 STOP. 4-way stop. Intersection with Illinois Route 127. Continue ahead straight.

1.35 56.5 The pumpjacks sitting atop platforms 10 to 15 feet above the Lost Creek bottoms are in the Posey oil field, an area of 300 proved acres of production. This field was discovered in 1941 with production coming from the Mississippian Cypress sand (fig. 4), which occurs here at an average depth of 1,105 feet. To the end of 1972, 28 wells had been completed into this sand pay zone that averages 5 feet in thickness and encompasses 290 proved acres. The pay zone occurs along a monoclinal structure. In 1959, a well was completed into the underlying Devonian limestone at a depth of 2,675 feet. This pay zone, which comprises 10 acres, averages 5 feet in thickness along the monocline. The deepest test hole in this field was stopped in Silurian strata at a depth of 2,798 feet. Oil production from this field during 1972 was 44,200 barrels from 26 active wells. Total production up through 1972 amounted to 419,200 barrels of oil.

1.6 58.1 CAUTION. Prepare to turn left.

0.15 58.25 CAUTION. TURN LEFT off of highway and immediately cross UNGUARDED RAILROAD CROSSING. DO <u>NOT</u> STOP ON TRACKS. Continue ahead (north).

1.0 59.25 CAUTION. T-road. TURN RIGHT (east).

0.2 59.45 The well heads noted here are in the Hoffman oil field, which was discovered in 1939 and consists of a proved area of 360 acres. By the end of 1972, 16 wells had been completed into the Mississippian Cypress sand, which here averages 11 feet in thickness at a depth of 1,190 feet. This pay zone of 190 proved acres is situated on an anticline. An additional 36 wells have been completed into the underlying Mississippian Benoist sand at a depth of 1,320 feet. This latter pay zone averages 7 feet in thickness and covers 240 proved acres along the anticline. The deepest test hole in this field, as of the end of 1972, was stopped in Devonian strata at a depth of 2,914 feet. Oil production from this field during 1972 was 300 barrels from 30 wells. Cumulative oil production up through 1972 amounted to 793,600 barrels.

0.45 59.9 TURN LEFT (north) on lane to Hoffman Sand and Gravel Pit.

0.05 59.95 The corrugated iron building to the right is an abandoned enginehouse that formerly housed a motor to drive a bull wheel which in turn worked sucker rods back and forth to several well sites. Thus, one motor was able to pump several wells at the same time. Some of the sucker rods are still evident, as are a couple of the old well sites to the northeast of the enginehouse.

0.2 60.15 Stop 7. Hoffman Sand and Gravel Company office (NW¼ SE¼ SW¼ Sec. 2, T. 1 N., R. 2 W., Carlyle 15' Quadrangle.)

CAUTION: DO NOT GO NEAR THE EDGE OF THE PIT. ITS SIDES ARE UNDERMINED BY DREDGING AND WILL COLLAPSE.

At this gravel pit sand and gravel is being taken from a valley train. Valley trains are outwash deposits partly filling valleys that carried meltwater away from glacier margins. They are the principal sources of sand and gravel in Illinois.

We did not discover whether this deposit is Illinoian or Wisconsinan outwash. This bed may be as much as 100 feet thick here, and several water wells between here and Posey have penetrated similar thick deposits of sand and gravel. One well a mile west of Posey went through a 15-foot bed of sand, a layer of till, and an 80-foot layer of sand and gravel. If there is a layer of till over the deposit in this pit, it is Illinoian drift, but the Kaskaskia Valley contains outwash from several glaciations.

Sand and gravel sucked from the bottom of the pit by the floating dredge is screened by an automated plant and stockpiled. The pit produces an unusual variety of material. The fine aggregate (FA) grades are concrete sand (FA-1), mortar sand (FA-9), and blend sand for blacktopping (FA-10). The coarse aggregate (CA) grades produced are "seepage gravel" (CA-7) and pea gravel (CA-18).

This is a good place to collect rocks. A great variety can be found in glacial drift because the ice sheets picked up and moved rocks southward from the regions that they crossed between here and Canada.

PLEISTOCENE GLACIATIONS IN ILLINOIS

Origin of the Glaciers

During the past million years or so, the period of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. Ice sheets formed in sub-arctic regions four different times and spread outward until they covered the northern parts of Europe and North America. In North America the four glaciations, in order of occurrence from the oldest to the youngest, are called the Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. The limits and times of the ice movement in Illinois are illustrated in the following pages by several figures.

The North American ice sheets developed during periods when the mean annual temperature was perhaps 4° to 7° C (7° to 13° F) cooler than it is now and winter snows did not completely melt during the summers. Because the cooler periods lasted tens of thousands of years, thick masses of snow and ice accumulated to form glaciers. As the ice thickened, the great weight of the ice and snow caused them to flow outward at their margins, often for hundreds of miles. As the ice sheets expanded, the areas in which snow accumulated probably also increased in extent.

Tongues of ice, called lobes, flowed southward from the Canadian centers near Hudson Bay and converged in the central lowland between the Appalachian and Rocky Mountains. There the glaciers made their farthest advances to the south. The sketch below shows several centers of flow, the general directions of flow from the centers, and the southern extent of glaciation. Because Illinois lies entirely in the central lowland, it has been invaded by glaciers from every center.

Effects of Glaciation

Pleistocene glaciers and the waters melting from them changed the landscapes they covered. The glaciers scraped and smeared the landforms they overrode, leveling and filling many of the minor valleys and even some of the larger ones. Moving ice carried colossal amounts of rock and earth, for much of what the glaciers wore off the ground was kneaded into the moving ice and carried along, often for hundreds of miles.

The continual floods released by melting ice entrenched new drainageways, deepened old ones, and then partly refilled both with sediments as great quantities of rock and earth were carried beyond the glacier fronts. According to some estimates, the amount of water drawn from the sea and changed into ice during a glaciation was probably enough to lower sea level more than 300 feet below present level. Consequently, the melting of a continental ice sheet provided a tremendous volume of water that eroded and transported sediments.

In most of Illinois, then, glacial and meltwater deposits buried the old rock-ribbed, low, hill-and-valley terrain and created the flatter landforms of our prairies. The mantle of soil material and the deposits of gravel, sand, and clay left by the glaciers over about 90 percent of the state have been of incalculable value to Illinois residents.

Glacial Deposits

The deposits of earth and rock materials moved by a glacier and deposited in the area once covered by the glacier are collectively called drift. Drift that is ice-laid is called till. Water-laid drift is called outwash.

Till is deposited when a glacier melts and the rock material it carries is dropped. Because this sediment is not moved much by water, a till is unsorted, containing particles of different sizes and compositions. It is also unstratified (unlayered). A till may contain materials ranging in size from microscopic clay particles to large boulders. Most tills in Illinois are pebbly clays with only a few boulders.

Tills may be deposited as end moraines, the arc-shaped ridges that pile up along the glacier edges where the flowing ice is melting as fast as it moves forward. Till also may be deposited as ground moraines, or till plains, which are gently undulating sheets deposited when the ice front melts back, or retreats. Deposits of till identify areas once covered by glaciers. Northeastern Illinois has many alternating ridges and plains, which are the succession of end moraines and till plains deposited by the Wisconsinan glacier.

Sorted and stratified sediment deposited by water melting from the glacier is called outwash. Outwash is bedded, or layered, because the flow of water that deposited it varied in gradient, volume, velocity, and direction. As a meltwater stream washes the rock materials along, it sorts them by size--the fine sands, silts, and clays are carried farther downstream than the coarser gravels and cobbles. Typical Pleistocene outwash in Illinois is in multilayered beds of clays, silts, sands, and gravels that look much like modern stream deposits.

Outwash deposits are found not only in the area covered by the ice field but sometimes far beyond it. Meltwater streams ran off the top of the glacier, in crevices in the ice, and under the ice. In some places, the cobble-gravel-sand filling of the bed of a stream that flowed in the ice is preserved as a sinuous ridge called an esker. Cone-shaped mounds of coarse outwash, called kames, were formed where meltwater plunged through crevasses in the ice or into ponds along the edge of the glacier.

The finest outwash sediments, the clays and silts, formed bedded deposits in the ponds and lakes that filled glacier-dammed stream valleys, the sags of the till plains, and some low, moraine-diked till plains. Meltwater streams that entered a lake quickly lost speed and almost immediately dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were moved across the lake bottom by wind-generated currents, and the clays, which stayed in suspension longest, slowly settled out and accumulated with them.

Along the ice front, meltwater ran off in innumerable shifting and short-lived streams that laid down a broad, flat blanket of outwash that formed an outwash plain. Outwash was also carried away from the glacier in valleys cut by floods of meltwater. The Mississippi, Illinois, and Ohio Rivers occupy valleys that were major channels for meltwaters and were greatly widened and deepened during times of the greatest meltwater floods. When the floods waned, these valleys were partly filled with outwash far beyond the ice margins. Such outwash deposits, largely sand and gravel, are known as valley trains. Valley trains may be both extensive and thick deposits. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.

Loess and Soils

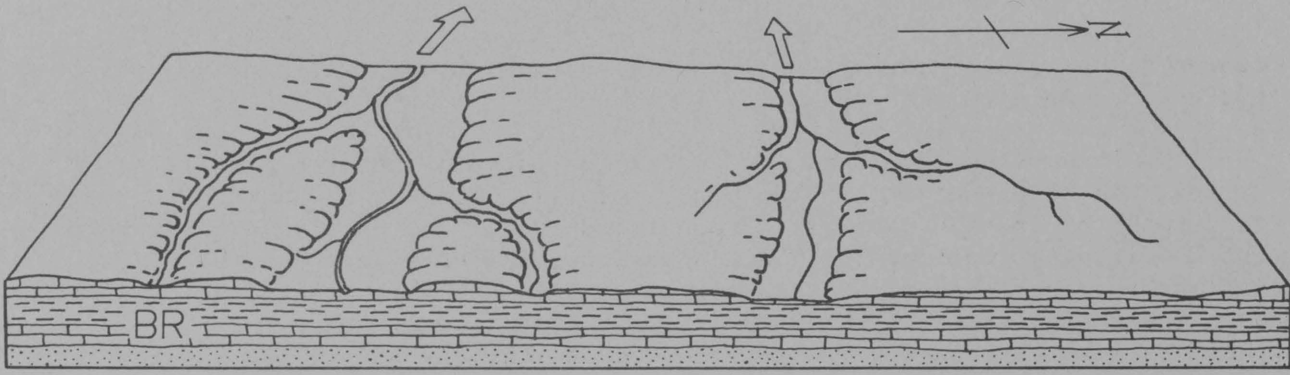
One of the most widespread sediments resulting from glaciation was carried not by ice or water but by wind. Loess is the name given to such deposits of windblown silt and clay. The silt was blown from the valley trains on the floodplains. Most loess deposition occurred in the fall and winter seasons when low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and permitting them to dry out. During Pleistocene time, as now, west winds prevailed, and the loess deposits are thickest on the east sides of the source valleys. The loess thins rapidly away from the valleys but extends over almost all the state.

Each Pleistocene glaciation was followed by an interglacial stage that began when the climate warmed enough to melt the glaciers and their snowfields. During these warmer intervals, when the climate was similar to that of today, drift and loess surfaces were exposed to weather and the activities of living things. Consequently, over most of the glaciated terrain, soils developed on the Pleistocene deposits and altered their composition, color, and texture. Such soils were generally destroyed by later glacial advances, but those that survive serve as keys to the identity of the beds and are evidence of the passage of a long interval of time.

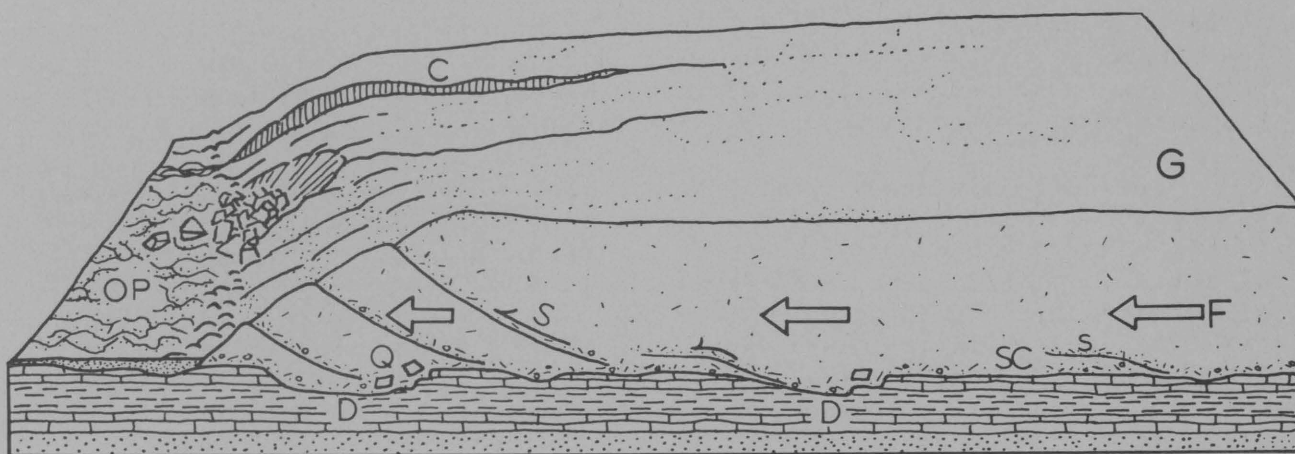
Glaciation in a Small Illinois Region

The following diagrams show how a continental ice sheet might have looked as it moved across a small region in Illinois. They illustrate how it could change the old terrain and create a landscape like the one we live on. To visualize how these glaciers looked, geologists study the landforms and materials left in the glaciated regions and also the present-day mountain glaciers and polar ice caps.

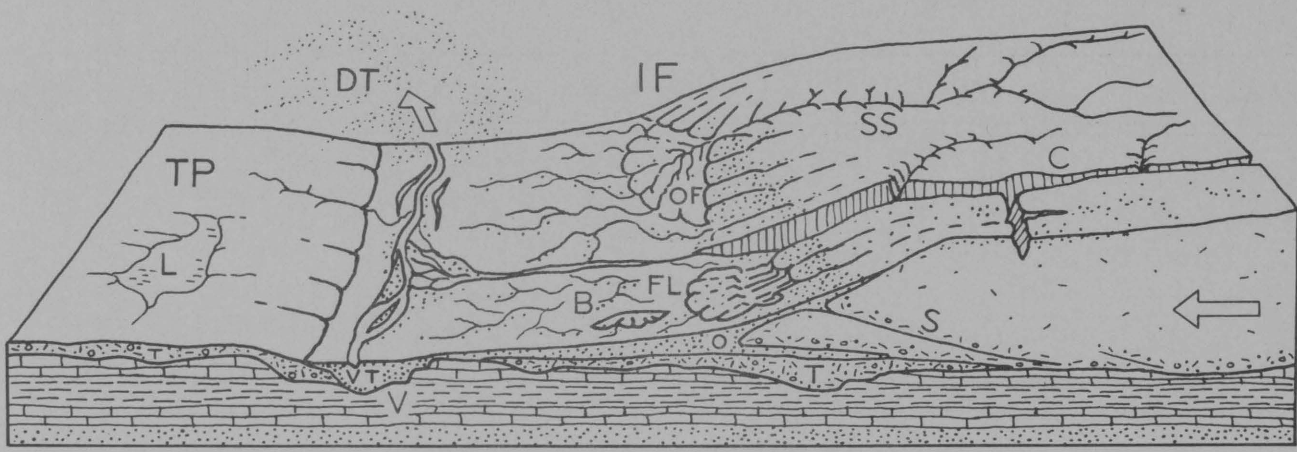
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated--layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



1. <u>The Region Before Glaciation</u> - Like most of Illinois, the region illustrated is underlain by almost flat-lying beds of sedimentary rocks--layers of sandstone ( ), limestone ( ), and shale ( ). Millions of years of erosion have planed down the bedrock (BR), creating a terrain of low uplands and shallow valleys. A residual soil weathered from local rock debris covers the area but is too thin to be shown in the drawing. The streams illustrated here flow westward and the one on the right flows into the other at a point beyond the diagram.



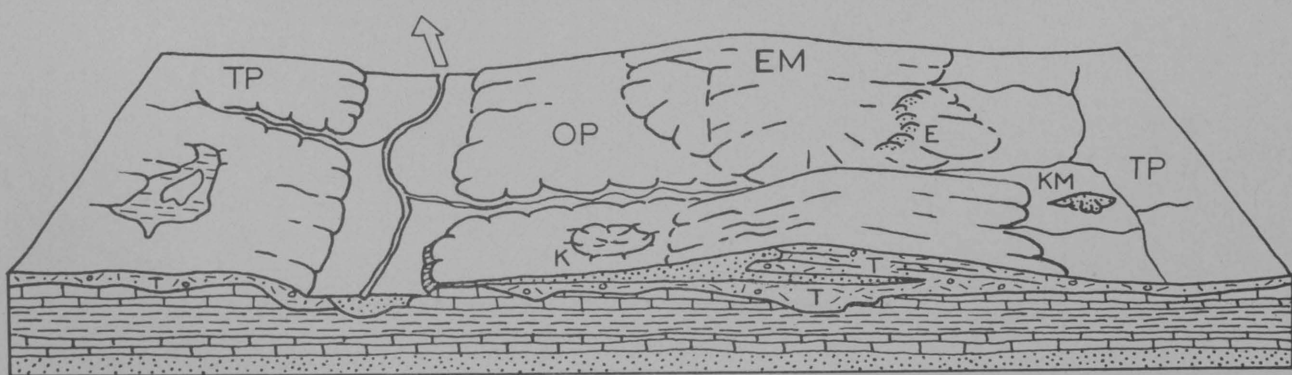
2. <u>The Glacier Advances Southward</u> - As the glacier (G) spreads out from its snowfield, it scours (SC) the soil and rock surface and quarries (Q)--pushes and plucks up--chunks of bedrock. These materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or stop flow (F), the ice "current" slides up over the blocked ice on innumerable shear planes (S). Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" (C) open parallel to the direction of ice flow. The glacier melts as it flows forward, and its meltwater erodes the terrain in front of the ice, deepening (D) some old valleys before the ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain (OP). The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick , except near its margin. Its ice front advances perhaps as much as a third of a mile per year.



3. The Glacier Deposits an End Moraine - After the glacier advanced across the area, the climate warmed and the ice began to melt as fast as it advanced. The ice front (IF) is now stationary, or fluctuating in a narrow area, and the glacier is depositing an end moraine.

As the top of the glacier melts, some of the sediment that was mixed in the ice accumulates on top of the glacier. Some is carried by meltwater onto the sloping ice front (IF) and out onto the plain beyond. Some of the debris slips down the ice front in a mudflow (FL). Meltwater runs through the ice in a crevasse (C). A superglacial stream (SS) drains the top of the ice, forming an outwash fan (OF). Moving ice has overridden an immobile part of the front on a shear plane (S). All but the top of a block of ice (B) is buried by outwash (O).

Sediment from the melted ice of the previous advance (figure 2) was left as a till layer (T), part of which forms the till plain (TP). A shallow, marshy lake (L) fills a low place in the plain. Although largely filled with drift, the valley (V) remained a low spot in the terrain. As soon as its ice cover melted, meltwater drained down the valley, cutting it deeper. Later, outwash partly refilled the valley--the outwash deposit is called a valley train (VT). Wind blows dust (DT) off the dry floodplain. The dust will form a loess deposit when it settles.



4. The Region after Glaciation - The climate has warmed even more, the whole ice sheet has melted, and the glaciation has ended. The end moraine (EM) is a low, broad ridge between the outwash plain (OP) and till plains (TP). Run-off from rains cuts stream valleys into its slopes. A stream goes through the end moraine along the channel cut by the meltwater that ran out of the crevasse in the glacier.

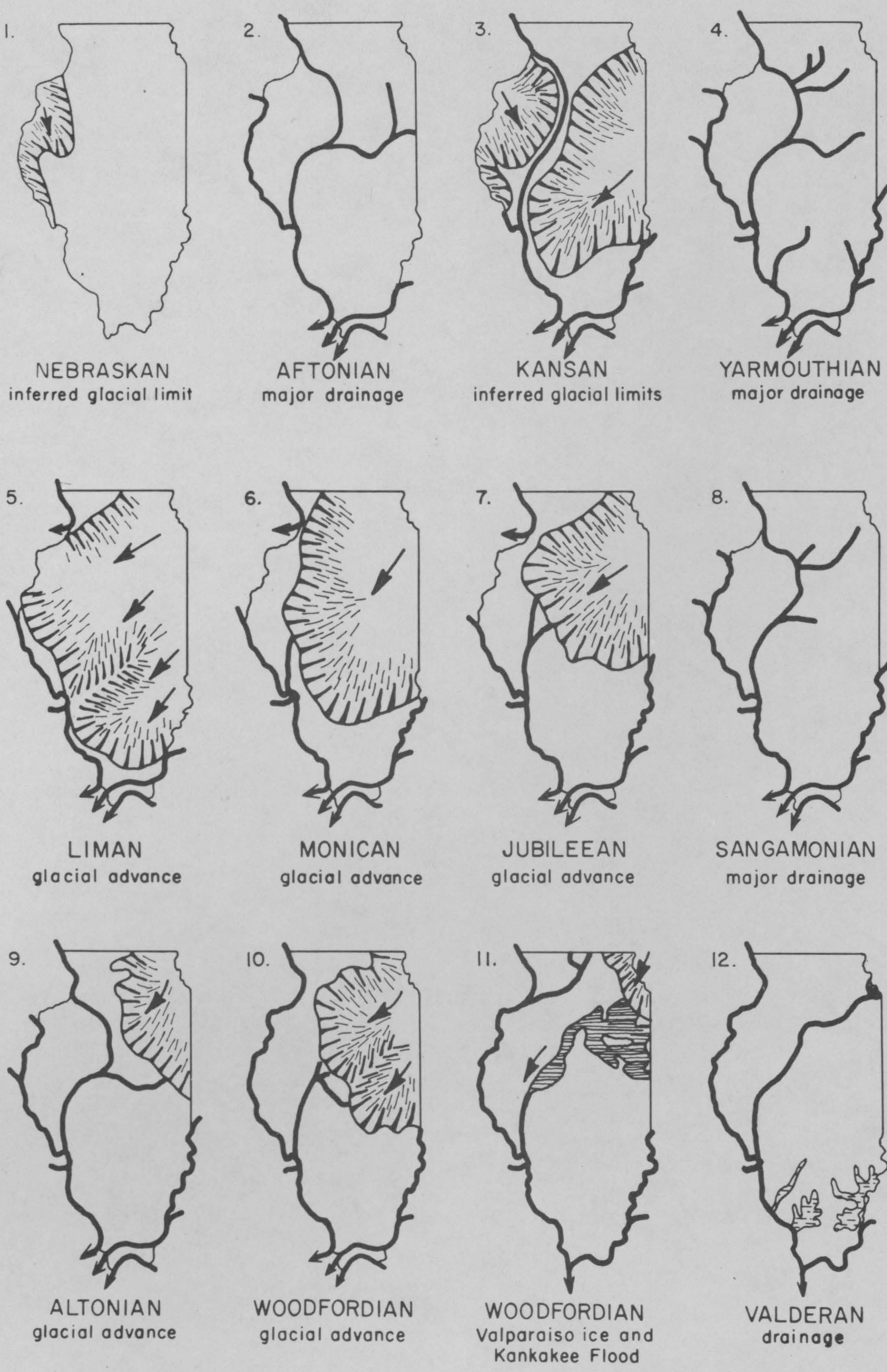
Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel into a crevasse or other depression in the glacier or at its edge is a kame (KM). A few feet of loess covers the entire area but cannot be shown at this scale.

TIME TABLE OF PLEISTOCENE GLACIATION

STAGE	SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
HOLOCENE	Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
	7,000		
WISCONSINAN (4th glacial)	Valderan	Outwash, lake deposits	Outwash along Mississippi Valley
	11,000		
	Twocreekan	Peat and alluvium	Ice withdrawal, erosion
	12,500		
	Woodfordian	Drift, loess, dunes, lake deposits	Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes
	22,000		
	Farmdalian	Soil, silt, and peat	Ice withdrawal, weathering, and erosion
	28,000		
	Altonian	Drift, loess	Glaciation in northern Illinois, valley trains along major rivers
	75,000		
SANGAMONIAN (3rd interglacial)		Soil, mature profile of weathering	
	175,000		
ILLINOIAN (3rd glacial)	Jubileean Monican Liman	Drift, loess Drift, loess Drift, loess	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
	300,000		
YARMOUTHIAN (2nd interglacial)		Soil, mature profile of weathering	
	600,000		
KANSAN (2nd glacial)		Drift, loess	Glaciers from northeast and northwest covered much of state
	700,000		
AFTONIAN (1st interglacial)		Soil, mature profile of weathering	
	900,000		
NEBRASKAN (1st glacial)		Drift	Glaciers from northwest invaded western Illinois
	1,200,000 or more		

(Illinois State Geological Survey, 1973)

SEQUENCE OF GLACIATIONS AND INTERGLACIAL DRAINAGE IN ILLINOIS



(From Willman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)

ILLINOIS STATE GEOLOGICAL SURVEY

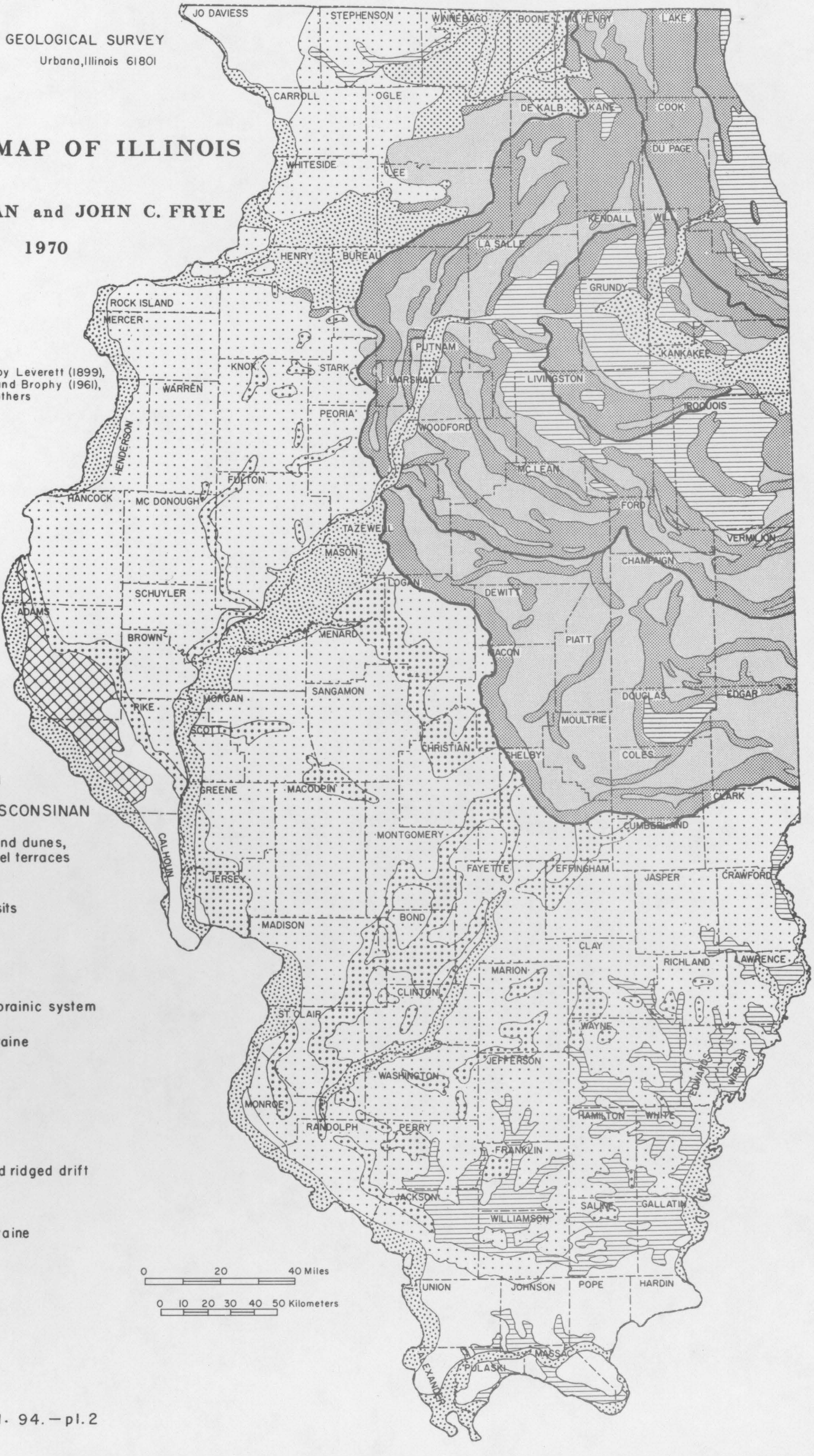
John C. Frye, Chief   Urbana, Illinois 61801

GLACIAL MAP OF ILLINOIS

H.B. WILLMAN and JOHN C. FRYE

1970

Modified from maps by Leverett (1899), Ekblaw (1959), Leighton and Brophy (1961), Willman et al. (1967), and others



EXPLANATION

HOLOCENE AND WISCONSINAN

- Alluvium, sand dunes, and gravel terraces

WISCONSINAN

- Lake deposits

WOODFORDIAN

- Moraine
- Front of morainic system
- Groundmoraine

ALTONIAN

- Till plain

ILLINOIAN

- Moraine and ridged drift
- Groundmoraine

KANSAN

- Till plain

DRIFTLESS

Modified from Bull. 94.—pl. 2

DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS

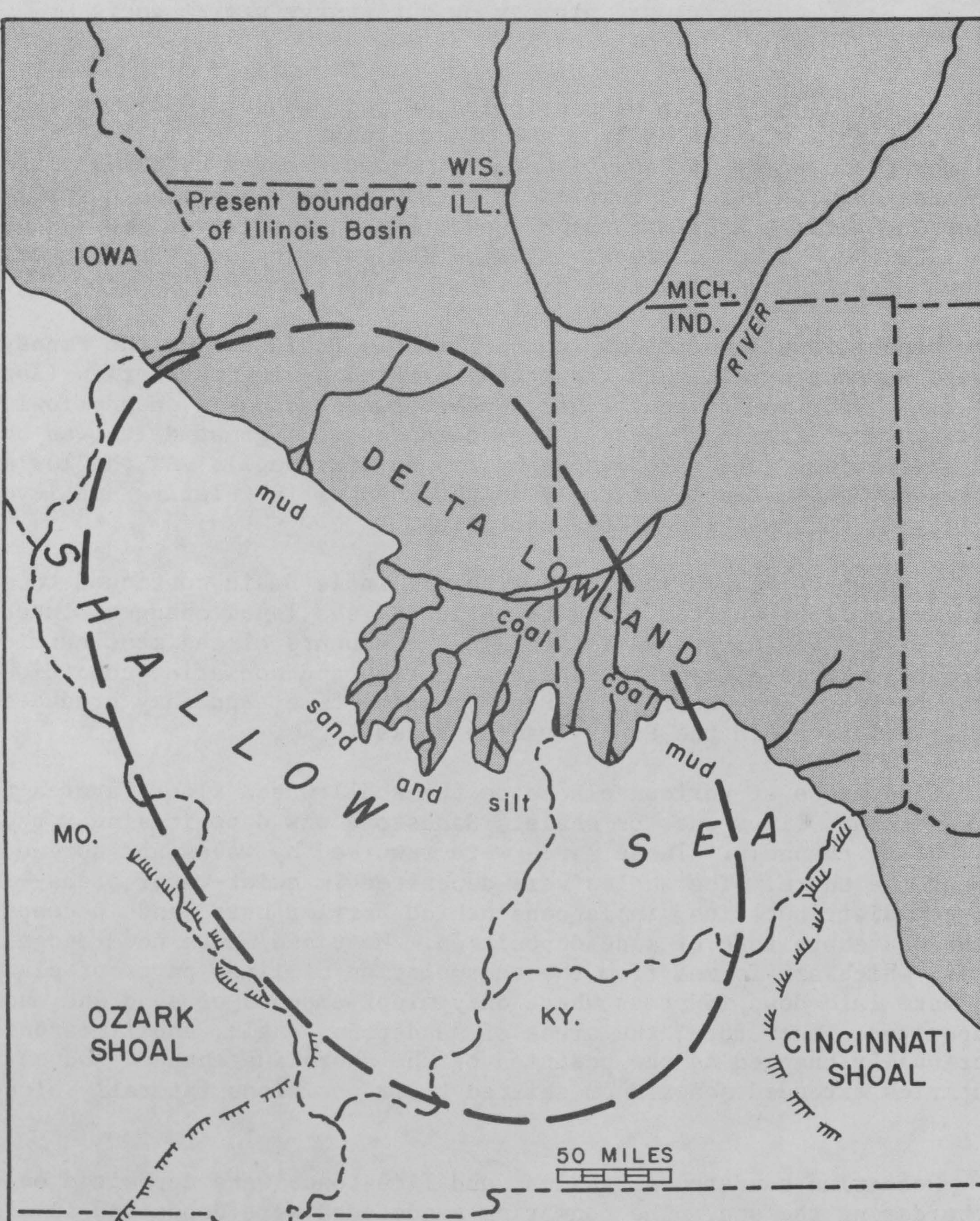
At the close of the Mississippian Period, about 310 million years ago, the Mississippian sea withdrew from the Midcontinent region. A long interval of erosion took place early in Pennsylvanian time and removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. An ancient river system cut deep channels into the bedrock surface. Erosion was interrupted by the invasion of the Morrowan (early Pennsylvanian) sea.

Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those that existed during Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands in the northeast. A great delta was built out into the shallow sea (see paleogeography map on next page). As the lowland stood only a few feet above sea level, only slight changes in relative sea level caused great shifts in the position of the shoreline.

Throughout Pennsylvanian time the Illinois Basin continued to subside while the delta front shifted owing to worldwide sea level changes, intermittent subsidence of the basin, and variations in the amounts of sediment carried seaward from the land. These alternations between marine and nonmarine conditions were more frequent than those during pre-Pennsylvanian time, and they produced striking lithologic variations in the Pennsylvanian rocks.

Conditions at various places on the shallow sea floor favored the deposition of sandstone, limestone, or shale. Sandstone was deposited near the mouths of distributary channels. These sands were reworked by waves and spread as thin sheets near the shore. The shales were deposited in quiet-water areas—in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the nearshore zone of sand deposition. Most sediments now recognized as limestones, which are formed from the accumulation of limey parts of plants and animals, were laid down in areas where only minor amounts of sand and mud were being deposited. Therefore, the areas of sandstone, shale, and limestone deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sandstones, shales, and limestones were deposited on the deltaic lowland bordering the sea. The nonmarine sandstones were deposited in distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies, 100 or more feet thick, were deposited in channels that cut through many of the underlying rock units. The shales were deposited mainly on floodplains. Freshwater limestones and some shales were deposited locally in fresh-water lakes and swamps. The coals were formed by the accumulation of plant material, usually where it grew, beneath the quiet waters of extensive swamps that prevailed for long intervals on the emergent delta lowland. Lush forest vegetation, which thrived in the warm, moist Pennsylvanian climate, covered the region. The origin of the underclays beneath the coals is not precisely known, but they were probably deposited in the swamps as slackwater muds before the formation of the coals. Many underclays contain plant roots and rootlets that appear to be in their original places. The formation of coal marked the end of the nonmarine portion of the depositional cycle, for resubmergence of the borderlands by the sea interrupted nonmarine deposition, and marine sediments were then laid down over the coal.



Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows the Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

Pennsylvanian Cyclothems

Because of the extremely varied environmental conditions under which they formed, the Pennsylvanian strata exhibit extraordinary variations in thickness and composition, both laterally and vertically. Individual sedimentary units are often only a few inches thick and rarely exceed 30 feet thick. Sandstones and shales commonly grade laterally into each other, and shales sometimes interfinger and grade into limestones and coals. The underclays, coals, black shales, and limestones, however, display remarkable lateral continuity for such thin units (usually only a few feet thick). Coal seams have been traced in mines, outcrops, and subsurface drill records over areas comprising several states.

The rapid and frequent changes in depositional environments during Pennsylvanian time produced regular or cyclical alternations of sandstone, shale, limestone, and coal in response to the shifting front of the delta lowland. Each series of alternations, called a cyclothem, consists of several marine and nonmarine rock units that record a complete cycle of marine invasion and retreat. Geologists have determined, after extensive studies of the Pennsylvanian strata in the Midwest, that an ideally complete cyclothem consists of 10 sedimentary units. The chart on the next page shows the arrangement. Approximately 50 cyclothems have been described in the Illinois Basin, but only a few contain all 10 units. Usually one or more are missing because conditions of deposition were more varied than indicated by the ideal cyclothem. However, the order of units in each cyclothem is almost always the same. A typical cyclothem includes a basal sandstone overlain by an underclay, coal, black sheety shale, marine limestone, and gray marine shale. In general, the sandstone-underclay-coal portion (the lower 5 units) of each cyclothem is nonmarine and was deposited on the coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partly marine. The units above the coal are marine sediments and were deposited when the sea advanced over the delta lowland.

Origin of Coal

It is generally accepted that the Pennsylvanian coals originated by the accumulation of vegetable matter, usually in place, beneath the waters of extensive, shallow, fresh-to-brackish swamps. They represent the last-formed deposits of the nonmarine portions of the cyclothems. The swamps occupied vast areas of the deltaic coastal lowland, which bordered the shallow Pennsylvanian sea. A luxuriant growth of forest plants, many quite different from the plants of today, flourished in the warm Pennsylvanian climate. Today's common deciduous trees were not present, and the flowering plants had not yet evolved. Instead, the junglelike forests were dominated by giant ancestors of present-day club mosses, horsetails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal variations in the climate. Many of the Pennsylvanian plants, such as the seed ferns, eventually became extinct.

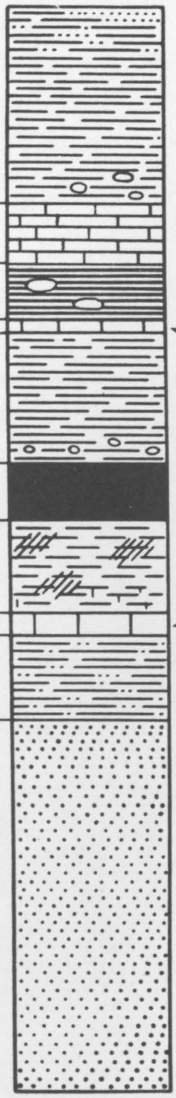
Plant debris from the rapidly growing swamp forests—leaves, twigs, branches, and logs—accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably stagnant and low in oxygen, prevented the complete oxidation and decay of the peat deposits.

The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests and initiated marine conditions of deposition. The peat deposits were buried by marine sediments. Following burial, the peat deposits were gradually transformed into coal by slow chemical and physical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coalification process, and the peat deposits were changed into coal.

Coals have been classified by ranks that are based on the degree of coalification. The commonly recognized coals, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each increase in rank is characterized by larger amounts of fixed carbon and smaller amounts of oxygen and other volatiles. Hardness of coal also increases with increasing rank. All Illinois coals are classified as bituminous.

Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached to a bleached appearance, and generally contain plant roots, many geologists consider that they represent the ancient soils on which the coal-forming plants grew.

The exact origin of the carbonaceous black shales that occur above many coals is uncertain. The black shales probably are deposits formed under restricted marine (lagoonal) conditions during the initial part of the invasion cycle, when the region was partially closed off from the open sea. In any case, they were deposited in quiet-water areas where very fine, iron-rich muds and finely divided plant debris were washed in from the land. The high organic content of the black shales is also in part due to the carbonaceous remains of plants and animals that lived in the lagoons. Most of the fossils represent planktonic (floating) and nektonic (swimming) forms—not benthonic (bottom dwelling) forms. The depauperate (dwarf) fossil forms sometimes found in black shales formerly were thought to have been forms that were stunted by toxic conditions in the sulfide-rich, oxygen-deficient waters of the lagoons. However, study has shown that the "depauperate" fauna consists mostly of normal-size individuals of species that never grew any larger.



10 Shale, gray, sandy at top; contains marine fossils and ironstone concretions, especially in lower part.

9 Limestone; contains marine fossils.

8 Shale, black, hard, laminated; contains large spheroidal concretions and marine fossils.

7 Limestone; contains marine fossils.

6 Shale, gray; pyritic nodules and ironstone concretions common at base; plant fossils locally common at base; marine fossils rare.

5 Coal; locally contains clay or shale partings.

4 Underclay, mostly medium to light gray but dark gray at top; upper part noncalcareous, lower part calcareous.

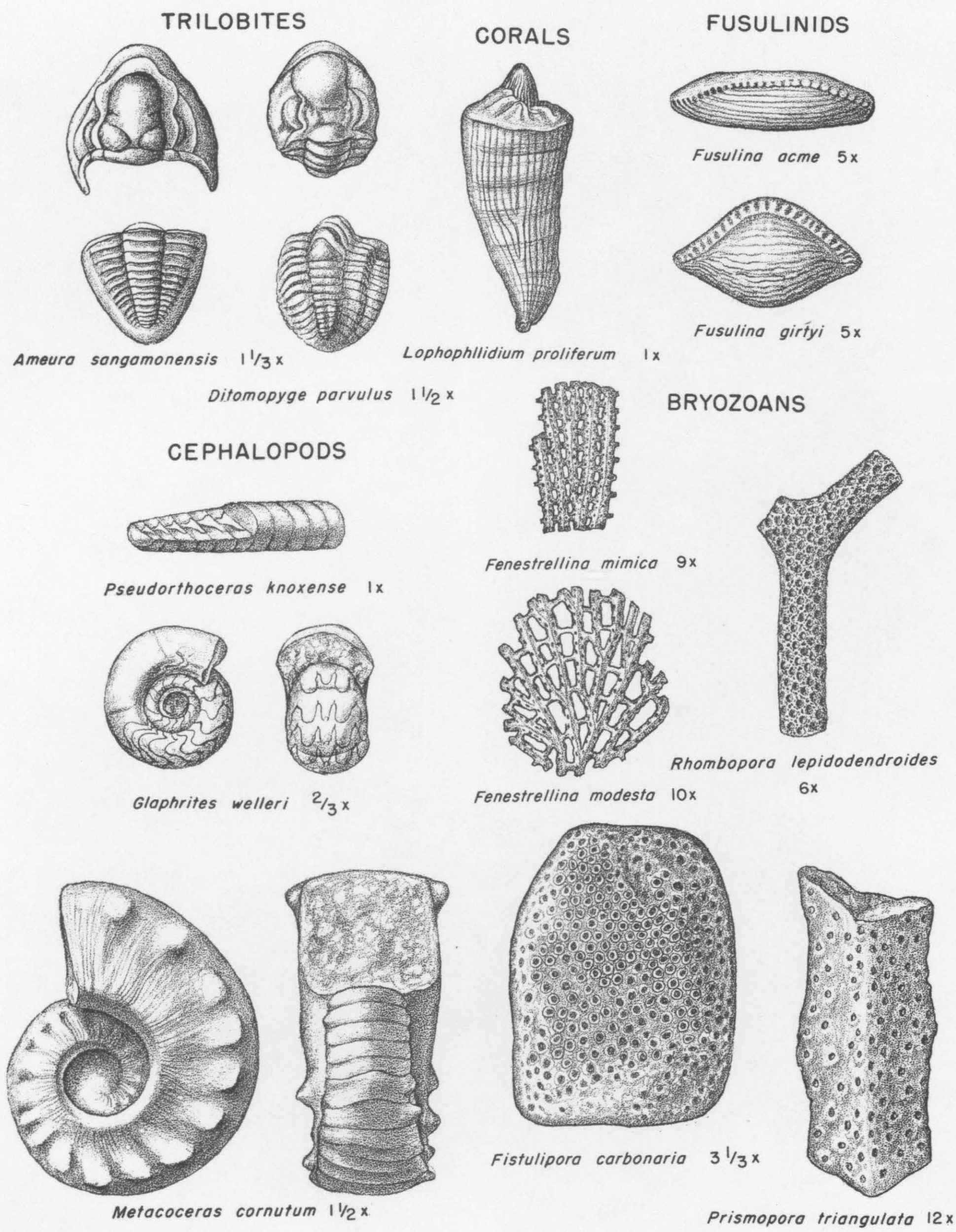
3 Limestone, argillaceous; occurs in nodules or discontinuous beds; usually nonfossiliferous.

2 Shale, gray, sandy.

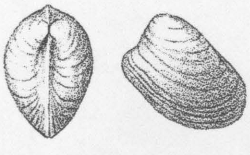
1 Sandstone, fine grained, micaceous, and siltstone, argillaceous; varies from massive to thin bedded; usually has an uneven lower surface.

AN IDEALLY COMPLETE CYCLOTHEM

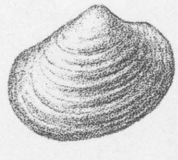
(Reprinted from Fig. 42, Bulletin No. 66, Geology and Mineral Resources of the Marseilles, Ottawa, and Streator Quadrangles, by H. B. Willman and J. Norman Payne)


TRILOBITES
CORALS
FUSULINIDS
Fusulina acme 5x
Fusulina girtyi 5x
Ameura sangamonensis 1 1/3 x
Lophophllidium proliferum 1x
Ditomopyge parvulus 1 1/2 x
BRYOZOANS
CEPHALOPODS
Pseudorthoceras knoxense 1x
Fenestrellina mimica 9x
Glaphrites welleri 2/3 x
Fenestrellina modesta 10x
Rhombopora lepidodendroides 6x
Metacoceras cornutum 1 1/2 x
Fistulipora carbonaria 3 1/3 x
Prismopora triangulata 12x

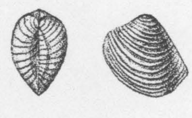
PELECYPODS



Nucula (Nuculopsis) girtyi 1x

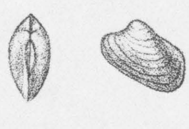


Edmonia ovata 2x

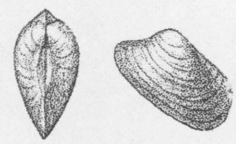


Astartella concentrica 1x

Dunbarella knighti 1½x

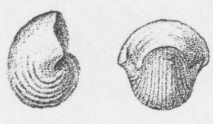


Cardiomorpha missouriensis "Type A" 1x

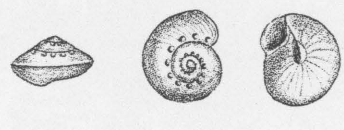


Cardiomorpha missouriensis "Type B" 1½x

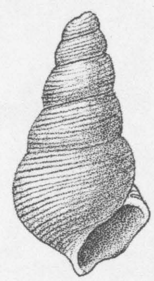
GASTROPODS



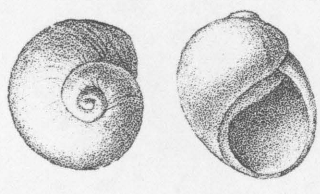
Euphemites carbonarius 1½x



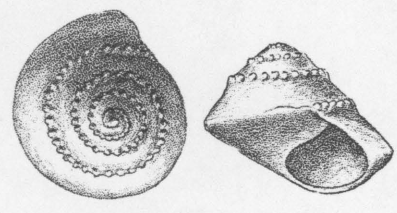
Trepospira illinoisensis 1½x



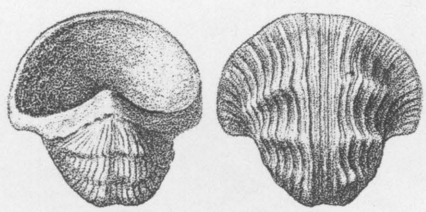
Donaldina robusta 8x



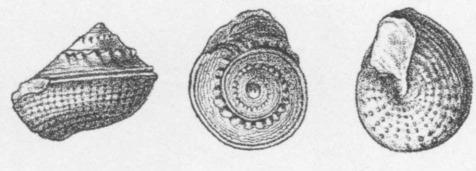
Naticopsis (Jedria) ventricosa 1½x



Trepospira sphaerulata 1x

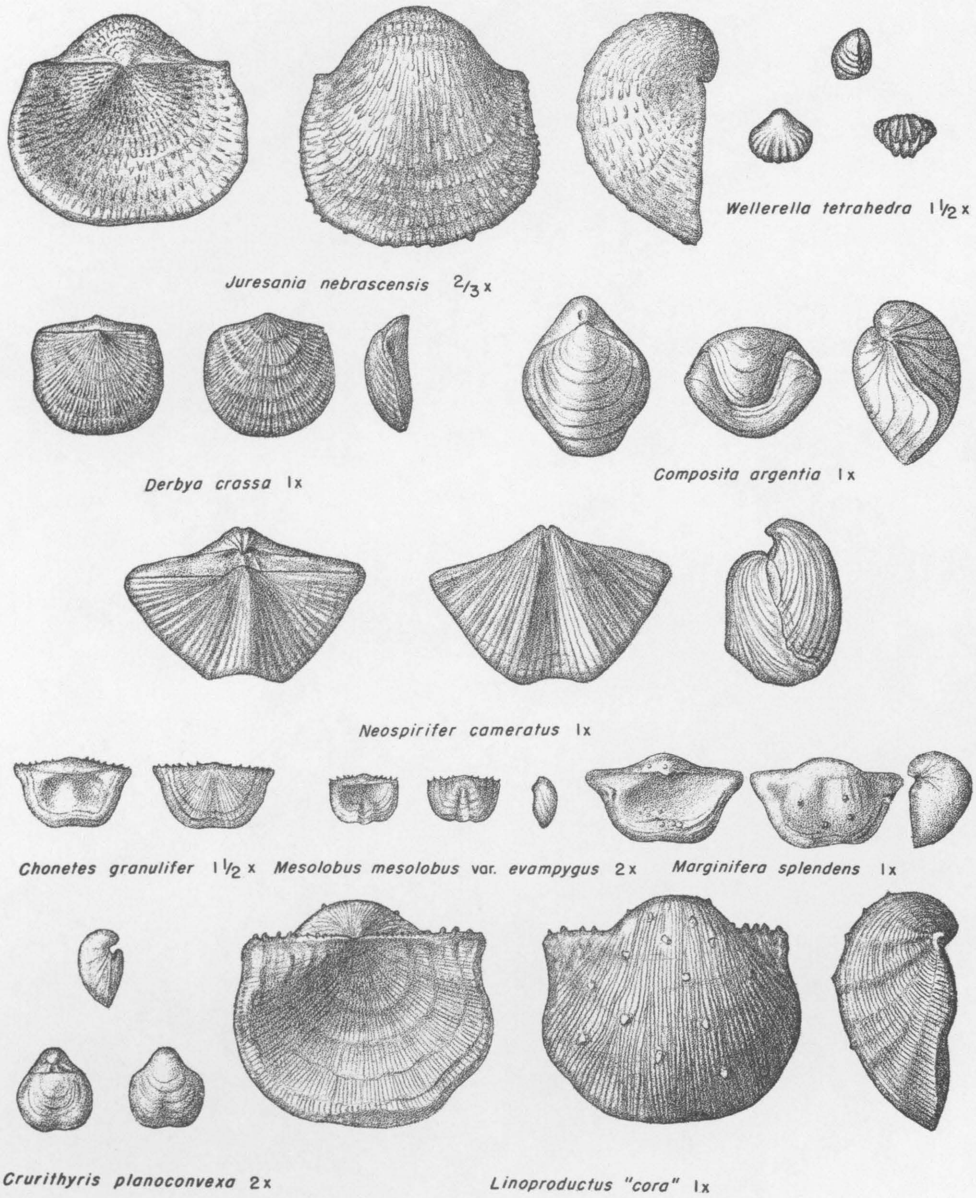


Knightites montfortianus 2x



Glabrocingulum (Glabrocingulum) grayvillense 3x

BRACHIOPODS

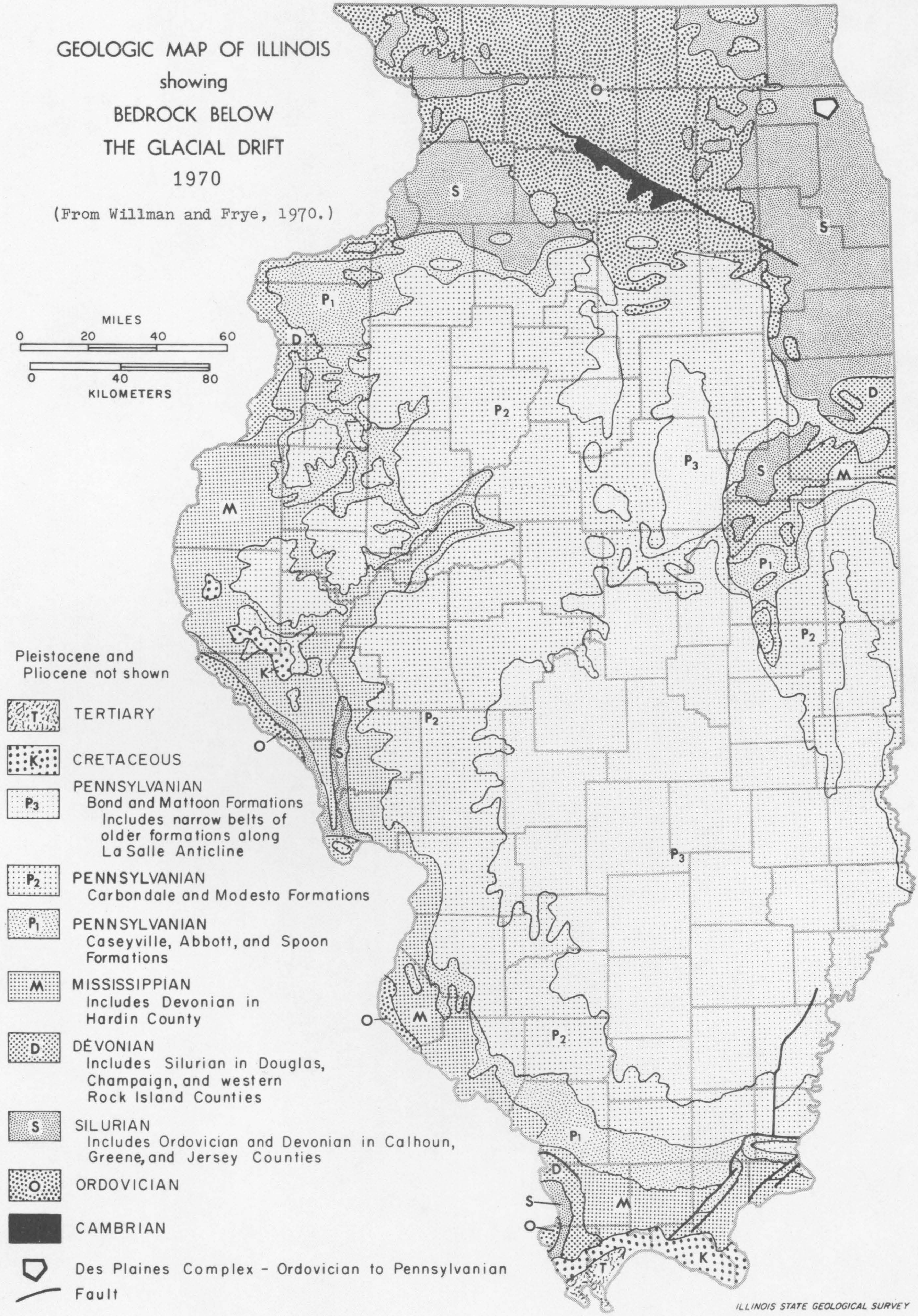


PHYSIOGRAPHIC DIVISIONS OF ILLINOIS

Reprinted 1970

GEOLOGIC MAP OF ILLINOIS
showing
BEDROCK BELOW
THE GLACIAL DRIFT
1970

(From Willman and Frye, 1970.)



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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
ILLINOIS
BREESE QUADRANGLE
ILLINOIS
CARLYLE QUADRANGLE
BREESE AREA
GEOLOGICAL SCIENCE FIELD TRIP
MAY 11 and OCTOBER 26, 1974
INACTIVE OR ABANDONED COAL MINE (NO. 6 COAL)
AREA IN WHICH COAL IS MINED OUT
ACTIVE LIMESTONE QUARRY
INACTIVE OR ABANDONED LIMESTONE QUARRY
EXPOSURES OF SHOAL CREEK LIMESTONE
INFERRED BURIED BEDROCK CONTACT BETWEEN THE PENNSYLVANIAN BOND (Pb) AND THE UNDERLYING MODESTO (Pm) FORMATIONS
ACTIVE SAND AND/OR GRAVEL PIT
AREA IN WHICH THERE IS RECORD OF OIL PRODUCTION
START
1
2
3
4
5
6
7
END
Pb
Pm
CARLYLE LAKE
BURGESS
ST ROSE
WHEATFIELD
IRISHTOWN
BREESE
WADE
CARLYLE
CLEMENT
SANTA FE
LAKE
COVINGTON
HOYLETON
Contour interval 20 feet
Datum is mean sea level
Edition of Sept. 1910, reprinted 1950 with corrections
Polyconic projection
CARLYLE, ILL.